[Established 1832]
THE OLDEST RAILROAD JOURNAL IN THE WORLD

AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY
BY
R. M. VAN ARSDALE (INC.)
140 NASSAU STREET, NEW YORK
J. S. BONSALL, Vice-President and General Manager

F. H. THOMPSON, Eastern Advertising Manager.

R. V. WRIGHT, E. A. AVERILL, } Editors.

MARCH, 1910

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trade, and a sound system of economics, including and emphasizing the philosophy of collective bargaining.

"In order to keep such schools in close touch with the trades, there should be local advisory boards, including representatives of the industries, employers and organized labor.

"The committee recommends that any technical education of the workers in trade and industry being a public necessity, it should not be a private but a public function, conducted by the public and the expense involved at public cost.

"There is a strong reaction coming in general methods of education, and that growing feeling, which is gaining rapidly in strength, that the human element must be recognized, can not be so disregarded as to make the future workers mere automatic machines.

"Experience has shown that manual training school teachers without actual trade experience, do not and cannot successfully solve this great problem, and that progress will necessarily be slow, as new teachers must be provided, a new set of textbooks will have to be written, and the subjects taught in a sympathetic and systematic manner."

* * * * * * *

J. Shirley Eaton has prepared a treatise on railway education which has been published as Bulletin No. 10, 1909, by the United States Bureau of Education. Mr. Eaton has collected information of everything important that is being done in the matter of educating railway employees in all departments; the mechanical department, or course, receives a large amount of attention, as more has probably been done in this department along these lines than in any other.

Mr. Eaton has made a number of valuable suggestions as to the best methods and principles to follow and his study should be in the hands of all officials who are interested in improving the efficiency of railway employees.

Among Mr. Eaton's conclusions are the following:

"Railways should extend the principles of definite apprenticeship to every department of the service, and should provide for two or more grades of apprentices in order to take account of differences in capacity and work done elsewhere, either in properly accredited schools or by experience, and leading to different grades of service.

"There should be formal provision for movement among departments under proper conditions, and the comity of railways should be so far extended as formally to provide for some interchange of officials under special restrictions.

"Efficiency should be recognized by an efficiency wage, stated distinctly apart from the seniority wage."

THE CANADIAN PACIFIC RAILWAY MALLET ARTICULATED LOCOMOTIVE.

Mr. Vaughan's new design of Mallet articulated locomotive has some original features which promise to prove very successful, as indicated by the preliminary tests which have been made of this engine, described in the opening article of this issue. The arrangement of the cylinders, both pairs of which are brought near together at about the middle of the locomotive, is new on this continent, although it has been used to some extent in France. This arrangement simplifies the construction and practically eliminates the possibility of leakage from the steam pipes, and also makes it possible to reduce the overall length of the engine to a minimum.

The superheater adds to both the economy and capacity of the locomotive. This feature should not be regarded as experimental, for it differs only in its method of application from the superheaters in general use on the Canadian Pacific Railway, which have been giving such successful results during the past few years.

Additional details of this interesting locomotive will be described in our next issue.

METHODS OF SUPERVISING MATERIAL COMPARED WITH METHODS OF SUPERVISING LABOR.

The material in a machine or structure is watched much more carefully than the labor.

Specifications describe in detail the quality of material wanted, and careful inspection insures the delivery of the grade specified. Detailed drawings planned by engineers and executed by skilled draftsmen show in complete detail the size, kind and shape of each piece. Buying is carried on by purchasing departments and orders placed for such quantities and lots that there will be a minimum of waste in using the material. The material after purchase is put in the hands of a store department, which keeps it under lock and key, only turning it over to the foreman when he states what quantity he wants and for what purpose. All this shows how carefully the material is planned for, bought, and watched over. The most brilliant talent of the organization is employed in this work.

A simple structure or machine is not built until complete plans are made as to sizes, kind and quality of material. The blueprint or shop drawing shows all these details. The shop foreman is required to follow the drawings completely. He gets his material from the store department, which in conjunction with the purchasing department has already accumulated from the same drawing the necessary stock. The foreman has nothing to do as to kind, quality or quantity of material. It is merely his duty to follow the plan or blue-print.

The labor that is to go into the finished structure or machine has not been planned for in the least. The gang of workmen to perform the job is turned over to the foreman, who has a free hand in directing when and how each necessary operation, that enters into the finished article, shall be done; yet in the average railroad shop the cost of labor is greater than that for material.

The usual process when a job is commenced is that there is a rush to get every man at work and from that instant the foreman's duties become one series of emergency moves to get out of difficulties that arise because no move has been planned ahead. Each worker or gang is moved along as best possible, doing what seems the most important thing at the minute, but directed by one who has neither the means nor the ability to see the work as a complete unit. The foreman or boss is busy driving those men or gangs that are not keeping up with the most advanced, and the advanced gangs are loafing or appearing to keep busy while waiting for the laggards to bring up the rear.

We use the best talent to direct the use of the material used by these gangs, but we leave the direction of when and how these gangs shall work to the ordinary gang boss who has not the training or ability to plan ahead. He takes the greatest pride and delight in his ability to get out of difficulties which, if a little planning ahead had been done, would not have occurred.

Material would be wasted if the drawing had not been made first. No plan of the labor is made first. Is not the waste of labor fully as great as that of material if we tried to build leaving the entire matter of material to the foreman as we do the matter of labor?

Running a shop or other organization is like a checker or chess game. The foreman is expected to play this game by getting the work past certain machines, men and gangs, at the same time advancing the work as a unit. This foreman is given nothing to help him see the whole shop at once. His leg capacity is usually the limit of his ability, for he must walk from machine to machine, gang to gang, and is only able to see the one part of his shop immediately in front of his eyes at one time. It would be a poor checker player who could only see one square ahead and in addition lost sight of all blocks except the one his hand was on at the time of making a move.

No one can carry the complete standing of all work even in a small shop in his head, much less see all the finer points of

the game compared with all the possible moves. Yet is this not about the thing we expect of our foremen and superintendents? They, as a rule, are not men to figure and plan ahead. Can we expect them to do so any more than we can expect them to be draftsmen, storekeepers or purchasing agents? This part of the game should be left to a separate department which will plan the time, sequence, and method of each move as definitely as the draftsman has planned sizes and shapes of material.

In the organizations of early industrial history the foreman or man on the work had the matter of material as completely in his control as the same man now has the matter of labor. He believed he was the only one who knew what kind and how much to use. He put up a vigorous kick in his way when he was relieved of this part of his duties, for, to quote a present day foreman, "Was he not right onto his job and didn't he know better than any one else what was wanted?" We are better off for our purchasing, store and draughting departments, for foremen are doing better work with better materials, fewer false moves, and less waste.

The next step in the advancement of industrial organization is a department which will plan ahead each move to be made by the workmen in as complete detail as our present blue-prints describe the use of material. The foreman's duties will be to follow these instructions as to labor with the same degree of exactness with which he now follows his blue-prints.

This department will be as separate from direct contact with the men and the shop as the present drawing room is. It will also be looked upon with ridicule by the present day foreman, but the future manager who has such a department installed as part of his organization will no more return to present methods than the present manager would do away with his efficient store, purchasing and draughting departments.

THE UNIT SYSTEM OF ORGANIZATION†

MAJOR CHARLES HINE.*

The primary object of this paper is to explain the details of the unit system of organization that is being installed on the Harriman Lines under the direction of Julius Kruttschnitt, director of maintenance and operation, Union Pacific System—Southern Pacific Company. It is not desired so much to theorize as to what might, could, would or should be done, but rather to narrate what has been accomplished in actual practice.

An essential feature of the system for each unit is a senior assistant, who, ranking next to the head of the unit, remains in charge of the headquarters' offices and acts as executive officer. This senior assistant is supposed to see, with common sense exceptions, all of the incoming and outgoing mail. If the other assistants are present at headquarters, they sign their own mail before it passes over the desk of the senior assistant for the latter's information. If an assistant is absent from headquarters he is represented, not by a chief clerk, but by a man of the wider experience of the senior assistant who signs the routine mail in his own name. The absent assistant is advised of the action taken by such methods as common sense and courtesy may suggest. Matters highly technical are held for the return of the assistant who is a specialist in that line.

The most difficult task in any organization of human endeavor is to correlate the activities of the workers on the outside with the necessary requirements of correspondence, records and accounting on the inside. The artisan in the shop, the traveling salesman on the road, the soldier in the field, the sailor at sea, the railroad man on the line, all have their troubles with the man in the office. When the inside man knows the outside game at first hand such differences in points of view are minimized, friction avoided, and therefore money saved. Railway operation is the most exacting of human tasks. Like the conduct of a household, a farm, a hotel or ship, it is a continuous performance. Unlike those exacting occupations it must maintain its own communications over hundreds or thousands of miles of territory. So complex is its administration that chances should not be taken of losing money through half baked decisions of partially trained office occupants. Most railway officials flatter themselves that when on the line they maintain a grasp on the office. Yet every hour in their absence action must be taken on matters which, apparently trivial in themselves, have far reaching results. This statement is not a reflection upon the splendid ability and earnestness of railway officials. It is merely a recognition of the fact that a man can be in only one place at a time; that there are only 24 hours in the day and only 365 days in the year. The salary of one official is negligible as a percentage of the operating cost of the average unit. Accordingly the system insists that the second best man of the unit, with practical outside training, shall stay at headquarters and sit on the lid. In some cases it has been found necessary to appoint another official to perform the previous outside duties of the senior assistant. In other cases it has been found that the outside work could be divided up among other members of the staff.

In any system of organization the most important unit is the individual. It is claimed that when one man signs the name of another the first by so much loses initiative and individuality. A man's name is his birthright, his signature his patent of enlightened manhood. Long habit on railways has perhaps minimized the pernicious effect of unconsciously building up one individual at the expense of many. Such industrial feudalism, however, can no more permanently endure than did the feudal serfdom of the middle ages. The unit system, therefore, insists that every man shall transact the company's business in his own name. There is nothing new in this. The whole system is really an extended application of the simple principles of train dispatching. A train order is addressed impersonally "Conductor and Engineman." Where proper discipline obtains the signatures to the orders are genuine. When the oldest conductor lays off the youngest extra man does not sign the former's name to orders and reports. Addresses in official matters should be impersonal because of the possible difficulty of identification; because of the resulting elasticity in interior administration. One does not ordinarily address a letter to an individual attaché of a firm, a bank, a hotel or a newspaper. He does not normally attempt to dictate who shall handle his communication. He leaves that to the intelligence and discretion of the organization that he is addressing. Under the unit system communications are addressed to the office—except when personal. The action taken, however, is by a real live man, whose identity is not concealed. The position is assumed that the recipient of a communication has the right to know what person is responsible therefor. The principle is established that except for a strictly personal staff, as for example a private secretary, all persons report ordinarily to a headquarters or an office and not to an individual. The authority of such headquarters or office is always exercised by an individual. Authority, in an enlightened organization of society or industry, should be impersonal. Its exercise is highly personal.

* Special Representative, Union Pacific System—Southern Pacific Company.

† A paper presented at the January meeting of the Western Railroad Club.

The application of the above established principle to the reorganization of an operating division requires that the assistant superintendent shall become the senior assistant. If previously there is no assistant superintendent the trainmaster, or most probable successor of the superintendent, becomes the senior assistant.

The next step in making the division a complete unit with its head, the superintendent, in effect general manager, is to move the division master mechanic and the traveling engineer (road foreman of engines) to the same building with the superintendent. The division shop as a sub-unit is left in charge of a general foreman. The old theory has been that a master mechanic if located at the shops can better supervise the shop forces. It is believed that the volume of business and complexity of modern conditions have outgrown this theory. It is found in practice that the master mechanic spends much of his time in an office near the shop writing letters to the superintendent, the superintendent of motive power and other officials. Again, human nature is such that the master mechanic so located may unconsciously dwell on the plane of the division shop foreman at the expense of the former's mechanical responsibilities along the road and at outlying terminals. When this results his value as a division official is diminished. The governing reason for locating the master mechanic and the traveling engineer with the superintendent is not only to gain a closer personal touch. Such contact is largely a matter of personal equation and of training regardless of location. The main object is to eliminate red tape by making possible a consolidation of files in one office of record. It has been demonstrated that relieved of a bureau of unnecessary correspondence the master mechanic can and does spend more hours among his men whether in shops, on the road, or at terminals.

Assuming that the division engineer, the trainmaster, and the chief dispatcher are already located in the same building with the superintendent, the division is ready for reorganization. The general superintendent and the instructor visit division headquarters where are assembled the division officials and their old chief clerks. In an informal lecture of two or three hours' duration the principles of the system and its unwritten laws are outlined. Explanations are given of the revised standard circular of organization, which reads as follows:

.....RAIL..... COMPANY.

..... DIVISION.

OFFICE OF SUPERINTENDENT.

CIRCULAR NO. .....

..... 191...

Effective ..... 191.... this division discontinues among its officials the use of titles—master mechanic, division engineer, trainmaster, traveling engineer, and chief dispatcher.

The following named officials are designated:

1. Mr. E. F. .....Assistant Superintendent.
2. Mr. G. H. .....Assistant Superintendent.
3. Mr. I. K. .....Assistant Superintendent.
4. Mr. L. M. .....Assistant Superintendent.
5. Mr. N. O. .....Assistant Superintendent.
6. Mr. P. Q. .....Assistant Superintendent.

They will be obeyed and respected accordingly.

Each of the above named officials continues charged with the responsibilities heretofore devolving upon him, and in addition assumes such other duties as may from time to time be assigned.

Such of the above as are located in the same building have one consolidated office file in common with the superintendent.

All reports and communications on the company's business, originating on this division, intended for the superintendent, or for any assistant superintendent, should be addressed simply, "assistant superintendent" (telegrams "A. S."), no name being used unless the communication is intended to be personal rather than official, in which case it will be held unopened for the person addressed. It is intended that an assistant superintendent shall always be on duty in charge of the division headquarters offices during office hours. The designation of a particular assistant superintendent to handle specified classes of correspondence and telegrams is a matter concerning only this office. Each official transacts business in his own name, and no person should sign the name or initials of another. The principle to guide subordinate officials and employees is to be governed by the latest instructions issued and received.

Train orders will be given over the initials of the train dispatcher on duty.

The modifications of pre-existing organization and methods herein ordered have been carefully worked out to expedite the company's business by the reduction and simplification of correspondence and records. It is expected and believed that officials and employees will insure a successful outcome by lending their usual intelligent co-operation and hearty support.

Officials and other persons outside the jurisdiction of this division are requested to address official communications, intended for the superintendent or any assistant superintendent, "Superintendent, ... Division, ..." (telegrams "Supt."), without using the name of the superintendent except for personal matter.

C. D.,
Superintendent.

APPROVED:

A. B.,
General Superintendent.

It will be observed that no distinct grade of senior assistant is created. The unwritten law is that whatever assistant is assigned to the charge of the headquarters' office becomes the senior for the time being. It was originally intended that different assistants should be detailed as the senior for certain definite periods. In some cases such a rigid rule may be necessary. The experience of a year indicates that the incidents and casualties of the service may usually be depended upon to let the situation work itself out. This is gratifying, since in such matters self-suggesting procedure is preferable to rigid rules. For example, if an assistant sprains his ankle or mashes his foot the superintendent can assign him to the office and send the then office man out on the road. Vacations and enforced absences afford the superintendent an opportunity to cover the situation by a common sense assignment. On one division the senior assistant was necessarily absent for some weeks. The maintenance assistant who happened to be next in rank was busy outside relaying the division with new steel. The third man, the mechanical assistant, had few troubles of his own in summer, and to him fell the opportunity to be broadened by a tour in the office. The superintendent and the other assistants, including the old traveling engineer, did the engine chasing. No circular was necessary, and there was less confusion than if two dispatchers had exchanged tricks.

In order that their authority may not be restricted when meeting a given emergency it is necessary to give the division officials the uniform title of assistant superintendent, without the limiting effect of a descriptive phrase. If any one can coin titles that will describe duties and not, under railway customs, restrict authority, such titles will be welcome. When a vacancy occurs the circular states, "Mr. ..... is appointed an assistant superintendent vice Mr. ....." His assignment to duty by the superintendent is verbal. If a superintendent should find himself with an assistant unfitted by temperament or experience to cope with a wider range of duties he could quietly restrict such assistant to a prescribed limit.

The assistant superintendents when at headquarters, except the senior assistant, have equal rank. On the road they have the relative rank indicated by the circular or the current working time table. In case two or more find themselves together and an interruption to traffic or other emergency requires, the highest on the list takes charge and becomes responsible. The system forces more officials to assume responsibility and by so much increases the protection to the company's interests. More and more is heard about "this division," and "the company" and less and less about "my department."

Most division officials have welcomed the title of assistant superintendent as a real promotion and as an increase in opportunity. Some still feel the loss of a distinctive title. Time alone will prove that railroading has become great enough as a profession to carry its own marks of distinction and to permit of a properly balanced specialization along the lines of greatest aptitude. Men like Julius Kruttschnitt, James McCrea, L. F. Loree, Epes Randolph, J. W. Kendrick, F. A. Delano and W. W. Atterbury, have not lost any reputation as civil and mechanical engineers because of their greater prominence as railway executives. For the same reason that a chief engineer blushingly accepts the title of vice-president, a division engineer should

modestly aspire to the position of assistant superintendent. This is one of the features of the unit system that it will take a generation to work out. Eventually an official cannot hope to perform the duties of chief engineer, or superintendent of motive power, until he has had experience in the grade of division superintendent. When superintendents are selected from diversified sources this will be possible. An advantage of the uniform title of assistant superintendent is that, as in the case of vice-presidents, it necessitates speaking of a particular official by name. When any official is away from his headquarters, he is addressed by name.

The unit system makes a distinction between superior or co-ordinate units and subordinate units. Employees address "assistant superintendent." If they addressed "superintendent" there would be an implied obligation on the part of the superintendent to answer. If his personal action is desired he must be addressed by name. Even though "assistant superintendent" is addressed the reply may be signed by the superintendent himself. Subject always to his superior's wishes, the superintendent makes his own office rules as to what he shall personally handle. It is up to him to see all, a part, or nothing for a given period, just as he sees fit. Should the superintendent's letter call for further information from the employee, the latter's reply would still be addressed, "assistant superintendent." For all that the sender knows the particular official may be necessarily absent when the letter is received. Numerous old conductors have expressed their appreciation of the fact that a man knows what official has addressed him, and that it is no longer possible to be jacked up by a clerk using the name of an official.

Communications from superior or co-ordinate authority are addressed to the head of the unit, the superintendent. In his absence routine matters for higher or co-ordinate authority are signed by the senior assistant who appends to his own title the explanatory phrase, "For and in the absence of the superintendent." Going down on the division no such explanation is necessary, as the authority of any assistant superintendent carries over the division itself.

The superintendent being in effect general manager of his division is given charge of division stores as well as division shops. He must, therefore, obey the instructions of the general storekeeper as well as the superintendent of motive power. The general storekeper has thus placed at his disposal all the administrative machinery of the division. Instead of a lack of practical sympathy between the stores and the users of material, it is made the duty of the superintendent and the assistant superintendents to watch material costs as well as labor costs, to help keep down interest charge on stocks as well as overtime. A railway company harnesses the forces of nature, including its divinely human elements, for one purpose, the manufacture and sale of an intangible commodity, transportation. The more closely interwoven the constituent parts of production the more efficient and economical should be the output. When weaknesses develop, when education is needed as to the increased importance of a given element, the remedy is not necessarily the creation of a separate department. A general storekeeper there should be, whatever his title, technically expert in his important specialty, responsible to the general manager and in a position to insist upon efficiency to the extent even of ordering material moved in special trains when it is true economy for the company to do so.

It will be noted that the superintendent, as the representative of all so-called departments on his division, has about as many superiors as he has assistants. The work of these superiors is balanced by the general manager. The scheme will not be fully effective until the unit system is applied to the general offices, making the general superintendent, the chief engineer, the superintendent of motive power, the general storekeeper, the car service agent, the superintendent of telegraph, the signal engineer, and the superintendent of dining cars all assistant general managers with one consolidated office file, and their activities co-ordinated by a senior assistant general manager at headquarters. Thus far only one general office, that of the new Oregon & Washington Railroad at Seattle, has been reorganized in accordance with this conception.

The number of divisions now reorganized is twenty-one with eleven still to follow. The number of assistant superintendents on a division varies from three to twelve. Every superintendent has shown his ability to handle as many assistants as the management may give him. The most gratifying feature of the reorganization is the fact that in all cases the talent at hand has been sufficient. No importations have been necessary. The incumbents of official positions have responded splendidly to the confidence reposed in their ability. Some divisions have gone farther than others. This always has been and always will be the case. Every one, however, has made real progress, some of it unconscious. The human element has been recognized. Division officials who from lack of early breadth of opportunity have not the qualifications for senior assistant are not required to fill the position. Their services to the company have been too faithful to warrant humiliation or elimination. Their grasp of present conditions is greater than could be that of student successors. When, in the course of nature, a new crop of officials matures it will be ripened younger but attain a fuller growth.

Consideration has been shown for the clerical forces affected by the changes. No individual has had his salary cut. As vacancies occur through natural causes salaries are readjusted; some increased, some diminished to meet the new conditions. All of these matters are left to the local officials. Principles are enunciated, suggestions made, but responsibility for details is left to the officials on the ground. The system means more officials and eventually fewer clerks. Probably by a cheese paring effort enough clerks could be eliminated to offset such increases in official salary lists as have been found necessary. The management has felt that increased supervision will warrant the outlay. This liberal policy is justified by good business sense rather than by the prosperity of the Harriman Lines. The poorer a road the more money it should spend for supervision and the development of esprit de corps.

Formerly office work was grouped around officials. This resulted in petty principalities and bureaucratic administration. By tearing down some office partitions there were razed those figurative department walls, which so often operate to keep in the man who is trying to keep the other fellow out. Under the new conception the work is grouped by classes. The technical term among business experts is "The concentration and co-ordination of routine and related processes." At a small roundhouse a handy man may be machinist, boiler maker and car repairer. In a large shop for obvious reasons the boiler makers and machinists are segregated. So, in an office, stenographers may be pooled, accountants segregated and clerks concentrated for the general good of the office work rather than for the fancied importance of a particular phase. The key to success in the unit system is a properly handled file room. It is given preferred attention and whatever force is necessary. When all of the clerks of the division are pooled no difficulty is experienced in finding sufficient to handle the file room. William's Railroad Classification is being installed with a view to uniform filing over the Harriman Lines.

As a general proposition officials at headquarters should not exchange written communications among themselves. Superintendents must apply this principle without hard and fast rules. For example, the superintendent of a heavy division being on the line some 200 miles from headquarters, very properly addressed a joint letter to each of his ten assistants, calling their attention to a wreck he had just picked up and as the lesson to be learned enjoining upon them a vigilant enforcement of certain rules. It has been found possible to reduce the correspondence of divisions reorganized from 30 to 50 per cent. Even with reduced clerical forces night and Sunday office work have been eliminated. The great reduction is made possible by the constant presence of the senior assistant who is alert to discourage the letter writing propensities of headquarters. It is expected that when all of the units under the Chicago office are reorgan-

ized there will be a net saving of at least 500,000 letters per year. Every letter costs a few cents to produce. Its retarding effect upon administration cannot be measured in money. Its dwarfing influence upon the individual initiative of the man below is likewise indeterminate. It is expected also that when the reorganization is completed numerous routine reports can be dispensed with.

It is not expected that a mere change of title or an assignment by a superintendent will make a man a skilled mechanic or an experienced engineer. For technical questions arising on a division the most expert knowledge available will continue to be utilized. It is claimed, however, that as the average division official has been in the service at least ten or fifteen years, he cannot fail to have acquired some familiarity with the requirements of the various branches of the work. The old trainmaster may as third trick dispatcher have ordered an engine taken down and towed in without awakening the master mechanic. By so much more should he with wider experience be able to say whether or not the company's interests are being best observed in the handling of a locomotive that may happen to come under his notice. The mechanical assistant cannot be everywhere and any help that his fellow officials can render the company should receive. Conflict of authority is avoided by the common sense and courtesy of the assistants and by the attention of the superintendent. Nothing makes men so conservative as responsibility. It is claimed that the superintendent on the ground is better able to decide these questions intelligently than is a hard and fast code formulated by a man behind a distant desk. What is construction to-day will be maintenance to-morrow. What is motive power at the turntable becomes transportation at the switch.

Each official continues responsible for his branch of the work until otherwise indicated by the superintendent. The maintenance assistant is not allowed to plead transportation duties as an excuse for defective track. With him track must come first. When the train stops he cannot inspect track until it resumes. Meantime he may be able to minimize the delay by seeing that employees perform their duties promptly. He is not allowed, except for insubordination, to discharge employees on another assistant's payroll. He is expected, however, tactfully and politely but forcefully, to insist that the rules be obeyed. The faithful old employees need only encouragement to perform their duties well. The young and inexperienced require constant supervision and instruction. Due to its great extent of territory a railway exercises less control over its employees than any other line of organized effort. The safety of lives and property demands the greatest possible intelligent supervision.

Adaptability to changed conditions is largely a matter of temperament. Among his intimates one can usually predict in advance what position a particular person will take on a question of politics, religion or organization. Some men believe in an early convergence of authority, in wide latitude of discretion. Others believe that the best results are obtained by postponing decisions until the highest possible authority is reached. On important questions there are usually two schools of opinion. Nearly every civilized country has two great political parties. On the railways of America there will always be diversity of opinions and practices as to the organization of forces. The executive officers of the Harriman Lines have felt that the individual will be broadened and the service correspondingly improved by the introduction of the elastic methods herein outlined. While many are enthusiastic, not all of the persons affected are convinced. It is to the credit of the latter that in spite of honest doubts all have contributed more or less to the success of the scheme. The work is being kept on a high plane, guided by those exalted ideals of duty; freedom from personalities, and the good of the service.

Some people evidently think that because the air brake is automatic and will "work itself," it should also "take care of itself."—*The Air Brake Magazine.*

USE OF AIR PUMP EXHAUST FOR HEATING FEED WATER.

The use of air pump exhaust for heating the tank water will effect a considerable saving. With a feed water temperature of 34 degrees it takes 1,198 heat units to convert the water into steam at 200 lbs. gauge pressure, but if the same feed water has been previously heated to 100 degrees, it requires only 1,132 heat units to accomplish the same result. Or, a saving of 5.5 per cent. is effected by heating the feed water to 100 degrees.

On some tests made in January, 1907, the average feed water temperature was 37 degrees, while those made in June on the same run on the ——— division had an average feed water temperature of 58 degrees. During July on the ——— division we obtained an average feed water temperature of 71 degrees. Therefore, it would seem reasonable to assume that for the entire system and for the entire year the average temperature of the water put in the engine tank is probably in the neighborhood of 55 degrees, or, in other words, this feed water is 45 degrees lower in temperature than it can safely be put into the injector.

Assuming that the steam delivered to the air pump and exhausted into the tank has, by the time it reaches the tank, dropped from 1,200 heat units to 1,000 heat units (which allows for loss of heat due to condensation and work done in the air pump), one pound of this value would raise 15 lbs. of water from 34 to 100 degrees. Or, in other words, if 6 2/3 of the total steam generated passed through the air pump and was exhausted into the tank, the entire amount of feed water would be raised from 34 to 100 degrees.

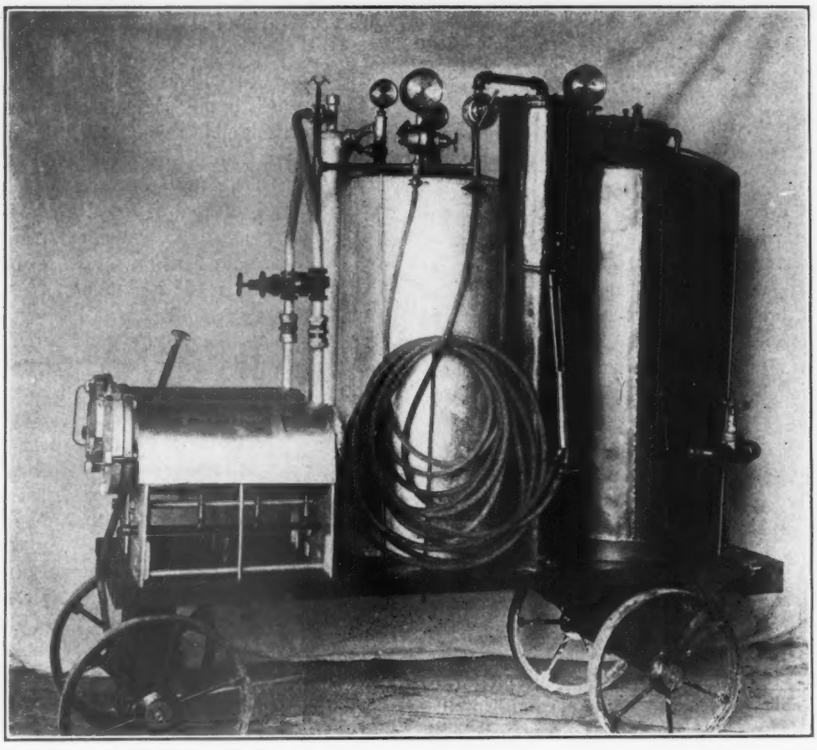
In looking over some tests made on freight trains and on passenger trains over the same division, I find that 5.3 per cent. of the total steam generated was used for operating the air pump on the freight runs, and on the passenger runs 1.9 per cent. of the total steam generated was used by the air pump. The freight runs were made on through trains making few stops and with comparatively little dead time, and the passenger trains were high speed, making only about six stops per trip.

It is then reasonable to assume that for the entire system probably four per cent. of the steam generated in the locomotive is used by the air pump, which means that four per cent. of the coal bill is chargeable to it; but a great percentage of the heat in the steam used by the air pump can be reclaimed by using the exhaust steam from it for heating the tank water. Under severe weather conditions there would probably not be enough exhaust steam to bring the feed water temperature to 100 degrees until the tank was about half empty.

It is believed that an average saving of 2½ per cent. can be made by the intelligent use of the air pump exhaust for heating the tank water.—*From a fuel engineer's notebook.*

ACCIDENTS REDUCED BY PAY-AS-YOU-ENTER CARS IN CHICAGO.—The Chicago City Railway has compiled comparative statistics of accidents before and after the introduction of pay-as-you-enter cars on its principal lines. Comparing the period from Nov. 24, 1906, to Jan. 31, 1908, which included but two months' operation of pay-as-you-enter cars on one line only, with the period from Nov. 24, 1907, to Jan. 31, 1909, during which pay-as-you-enter cars were in service on all trunk lines, the number of boarding and alighting accidents, accidents due to falling while the cars were rounding curves and accidents to persons stealing rides on cars was reduced 31.9 per cent.—*Electric Railway Journal.*

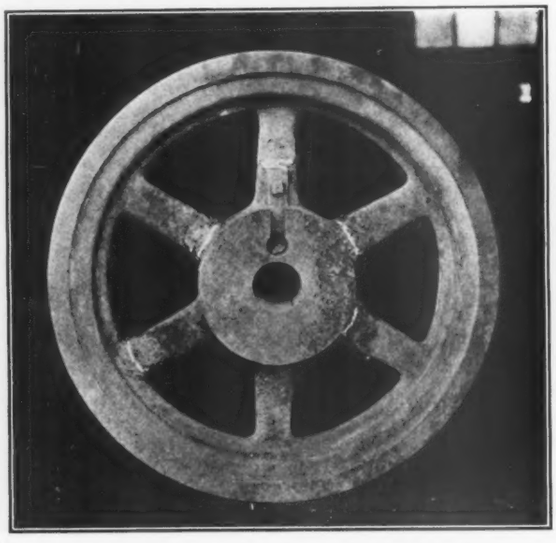
ENGINEERING.—Engineering is applied science, and its application is directed, in ninety-nine cases out of a hundred, to just one thing—*to making money for somebody.* No quality will be found of greater value to the engineer than commercial acumen. The young man who looks upon engineering *purely* as a science, or as the art of applying a science, independent of business principles, will very likely remain a drudge all his life, directed by men of far less scientific ability, but of greater business acumen. —*George Fillmore Swain of Harvard University.*



PORTABLE OXY-ACETYLENE WELDING OUTFIT.

OXY-ACETYLENE WELDING.

A difficult job in repairing the flue sheet of a locomotive firebox, by means of the oxy-acetylene welding process, is shown in the illustrations. The part which was cut away had been badly cracked and repaired by small patches and screw plugs. The new patch, of a very irregular shape, was cut out and fitted by means of the cutting attachment of the welding machine. An effort was made to expand the sheet with gas torches and thus neutralize the stresses due to contraction, but this did not work out successfully and the weld was cracked for a considerable distance at its ends.

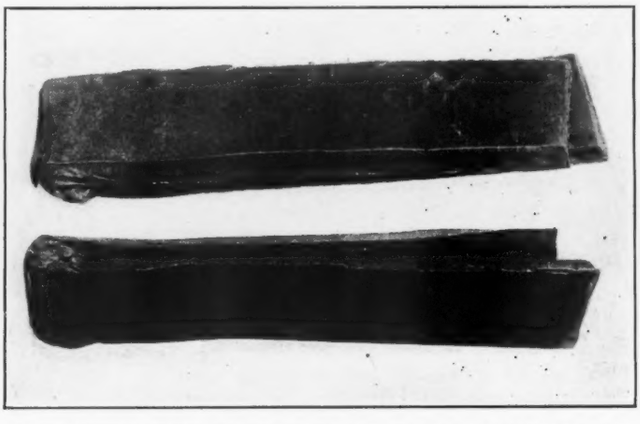


A DIFFICULT JOB IN WELDING. THE FIVE SPOKES WERE SUCCESSFULLY WELDED BY THE OXY-ACETYLENE PROCESS.

The sheet was then preheated locally and annealed with satisfactory results; the engine has been in service for some time since the weld was made, and is in first-class condition. The seam was approximately three feet long. It is an example of one of the most difficult pieces of work since it embraces a horizontal seam, which is difficult because of the possibility of laps or "cold shuts" at the upper edge of the weld; also the inverted weld which is very slow, yet is free from laps, since the metal that remains there is quite sure to be welded.

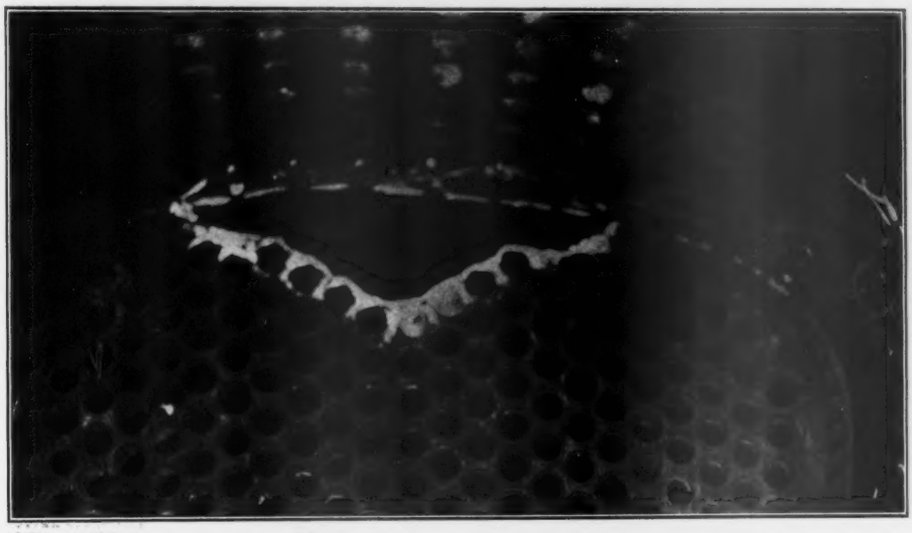
A space on the side sheet of this same firebox, about 16 in. in diameter, had a number of cracks at the stay bolts. These had been repaired by screw plugs and caulking, but were again giving trouble. The sheet was easily repaired with the oxy-acetylene welding process.

One of the illustrations shows two small test plates of ⅜ in boiler plate, which had been welded by the oxy-acetylene process. After cooling off they were bent at the weld and hammered flat under a steam hammer without fracturing the material. Another piece of the same size was welded and tested for tensile strength. No metal was piled on or added to the weld to reinforce it; the test showed 90 per cent. of the strength of the original piece.

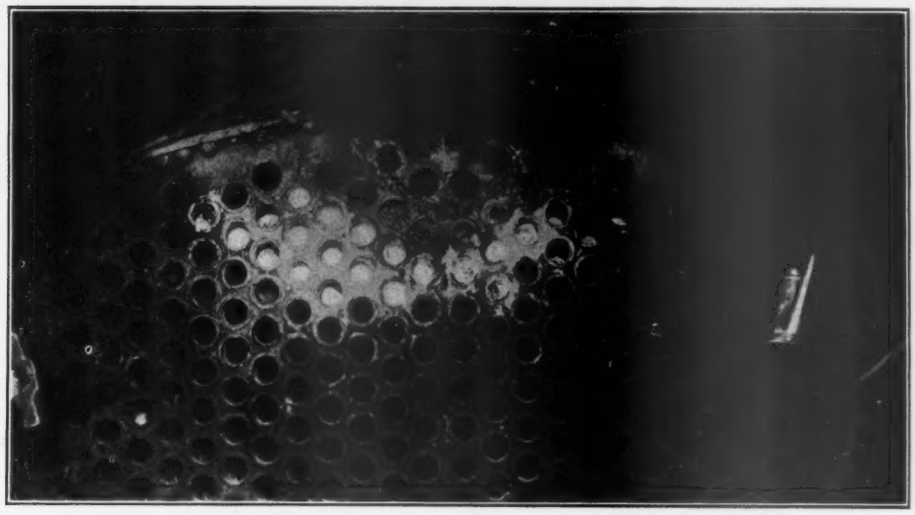


WELDED BOILER PLATE SUBJECTED TO SEVERE TEST. HAMMERED FLAT UNDER A STEAM HAMMER AFTER COOLING OFF.

Five of the spokes of the flywheel, also illustrated, were successfully welded. Those who are familiar with the difficulty in



SHOWING THE EXTENT OF THE PART THAT WAS REPLACED ON THE TUBE SHEET.



THE FIREBOX TUBE SHEET AFTER WELDING ON THE PATCH.

making repairs of this kind, due to expansion, will appreciate this piece of work.

The repairing of automobile parts with the oxy-acetylene blowpipe has become so common that it is not unusual to jack up an auto side frame and weld it *while you wait.*

The portable apparatus by which these welds were made is shown in one of the illustrations and is manufactured by the Oxy-Carbi Company of New Haven, Conn. An important feature of the apparatus is the use of double purifiers for generating oxygen, thus insuring a high quality of gas. The double gauge arrangement makes it possible to determine at any time whether either retort has exhausted its oxygen, and eliminates unnecessary waste of gas by overheating the retorts. Special alloy needle valves retain the gas in the storage tank when not used. Where much oxygen is used for cutting the retorts may be used alternately with very satisfactory results.

The acetylene generator is entirely automatic in action. By a slight turn of the regulator the working pressure may be adjusted to the required amount. Generation is immediately stopped without any waste when the consumption of gas is cut off. No odor of gas is noticeable from the machine, even if operated in a small room. The large carbide capacity makes it especially desirable for long runs or heavy work.

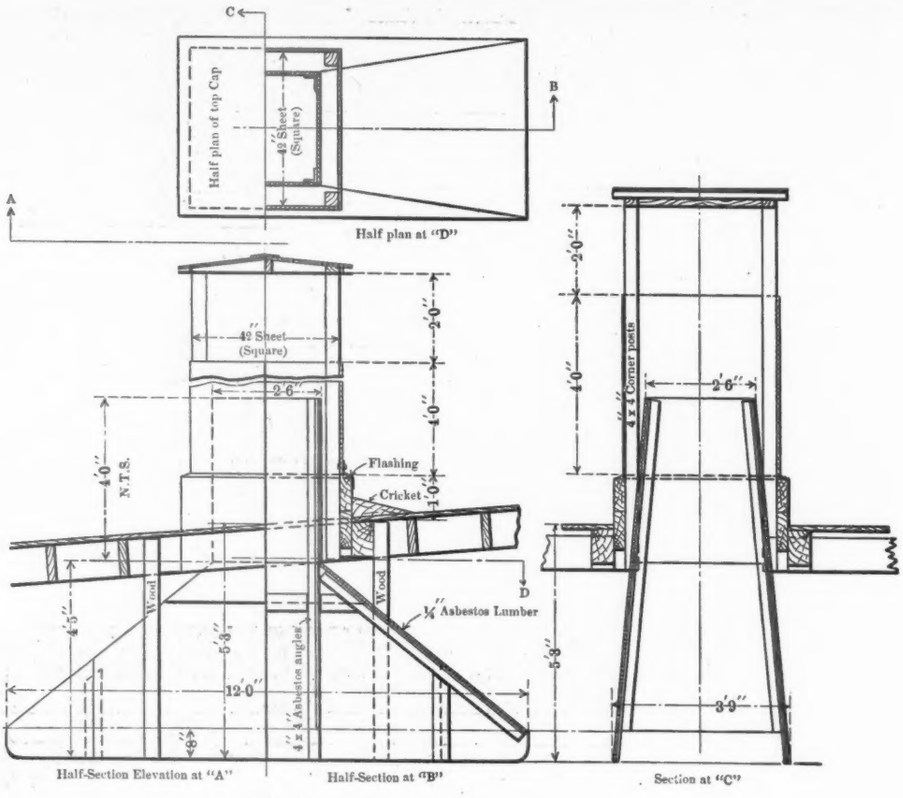
Railroads entering Atlanta, Ga., must publish a joint passenger train schedule in at least one of the daily papers.

OPERATION OF BRITISH PATENT ACT.

From a consular report it is noted that the first year's working of the British patents act has resulted in the introduction into the United Kingdom of $2,500,000 foreign capital. The value of the land and premises acquired by foreign firms who have decided to carry on their manufactures in Great Britain in order to maintain patent rights is estimated at $635,000. The expenditure for buildings was $880,000; plant and machinery, $895,000, making a total of $2,410,000. In addition, it is stated that a great many firms have arranged for English factories to manufacture their patented articles on a royalty basis.

The consul making the report is of the opinion that the results of the act have come up to expectations and believes its beneficial effect to England will continually increase.—*American Machinist.*

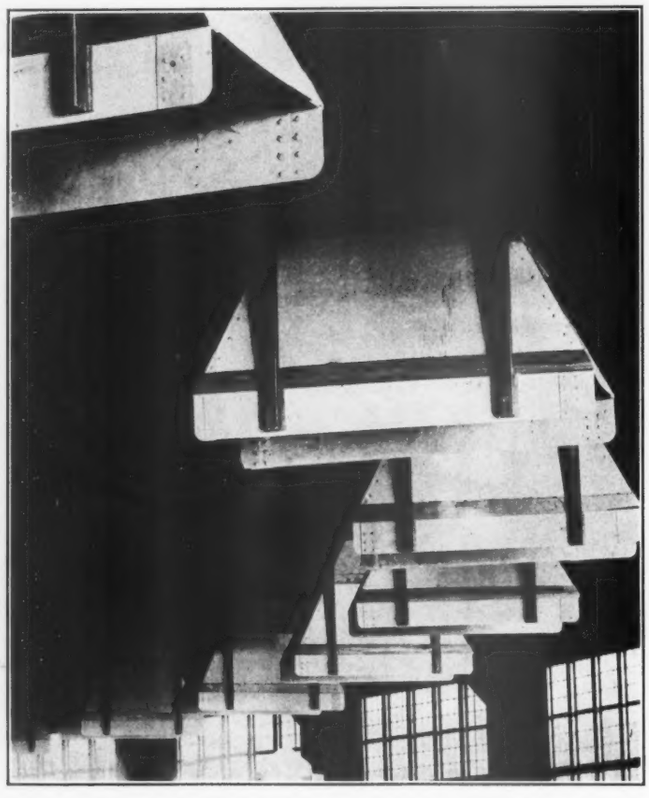
COLLEGE FOR APPRENTICES AT ALTOONA.—The trustees of the Pennsylvania State College have decided that the college, in connection with the Pennsylvania Railroad, shall establish a college for apprentices in the mechanical department of the Pennsylvania shops at Altoona. The school will begin with 30 students from the four-year apprentices at the shops. It will be started about the middle of February and be continued for three and one-half months. Instruction is to be given two afternoons each week.



APPLICATION OF ASBESTOS BOARD SMOKE JACK.

ASBESTOS BOARD SMOKE JACK.

On page 6 of the January issue in connection with the first part of the article on locomotive terminals was shown two interior views of the West Springfield engine house of the Boston & Albany Railroad, illustrating the arrangement and design of the smoke jacks. We are now able to illustrate the details of construction of these jacks and present a more satisfactory photograph.



ASBESTOS BOARD SMOKE JACK IN ENGINE HOUSE.

These jacks were designed on the basis of a most extensive and thorough study of the subject and illustrate probably the best present practice in this respect. The material selected was ¼ in. asbestos lumber furnished by the Franklin Mfg. Co., Franklin Pa., which presents many advantages for this construction. It is very light, is easily handled, is absolutely impervious to acids or gases, and is guaranteed for five years service and expected to have a life of over fifteen years. This lumber is made up of 85 per cent. Portland cement and 15 per cent. asbestos fibre, the corner angles being of the same material; the sheets are riveted with aluminium rivets. It is carried from the roof and braced on the outside by wooden timbers, which, of course, are not subject to deterioration.

It has seemed to be almost impossible to obtain a satisfactory material for smoke jacks, and if these jacks come up to expectations, as it is confidently expected that they will, one of the most troublesome problems of the mechanical and engineering departments will be solved.

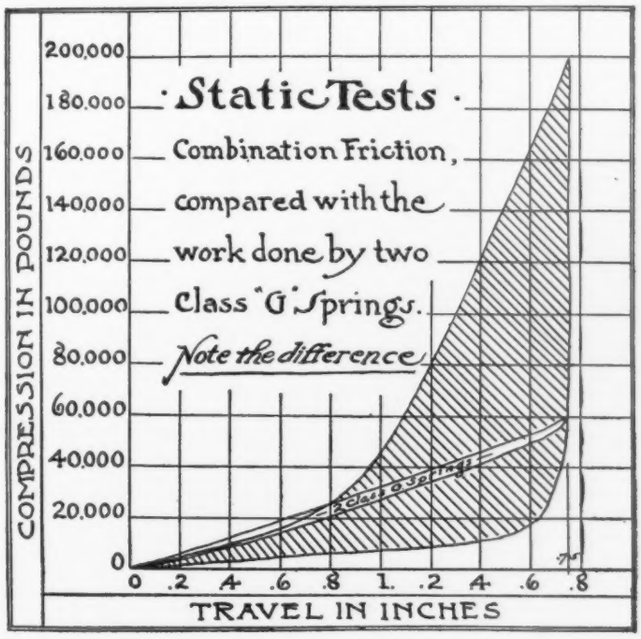
THE TUNGSTEN LAMP.—The tungsten lamp has practically revolutionized commercial lighting and is now being extensively adopted in industrial lighting, especially in textile mills. It is by far the most efficient of the incandescent class, and while the maintenance seems high in some cases, it is being rapidly reduced with the progress of development. Where lamps are protected from excessive vibration or shock, the tungsten is giving an exceedingly long burning life. In choosing between tungsten and tantalum, the cost of current and the size of unit desired are usually determining factors. Tungsten lamps are used singly or in groups with metal diffusers or prism glass reflectors. Where there is considerable building vibration, they are provided with spring suspensions.—*G. H. Stickney on the "Illumination for Industrial Plants" in Proceedings of the Am. Inst. of Electrical Engineers.*

FRICTION DRAFT GEAR.

The Butler Drawbar Attachment Company has adapted the friction elements of the friction draft gear, made by it under the Piper patents, to the Miner tandem class "G" spring gear for cars with 12⅞ in. sill spacing; this is done in such a manner that the spring gear can be raised from a 60,000-lb. to a 200,000 lb. capacity friction gear. The interesting tests of friction draft gears in actual service, made during the past year, have shown the great value of absorbing more of the shocks of buffs and jerks than is possible with the best of the spring gears. Col. W. B. Dunn, chief inspector of the Bureau for the Safe Transportation of Explosives and other Dangerous Articles, in speaking of recent tests of the shocks of loaded cars, says that "the results show in a striking manner the value of the friction draft gear in reducing impact pressures."

In applying the Butler friction elements to the Miner spring gear, no material need be thrown away, as that which is removed is still good for repairs. The friction element introduced is not an experiment, as it is now in use in thousands of cars, and the slight change in the "Miner" makes an improvement to the gears now in service, which is of great value and at the same time is comparatively inexpensive.

A static test of this combined gear gives a splendid card, the



action of the single "G" spring giving a fine preliminary movement, the friction elements gradually coming into action without a sudden jump or shock, a thing which tests in quick impact have shown often prevents the friction parts going into operation at all. This fact makes the early spring movement a valuable feature in the gear, as well as taking up the very large amount of slight shocks incident to shifting and starting movements.

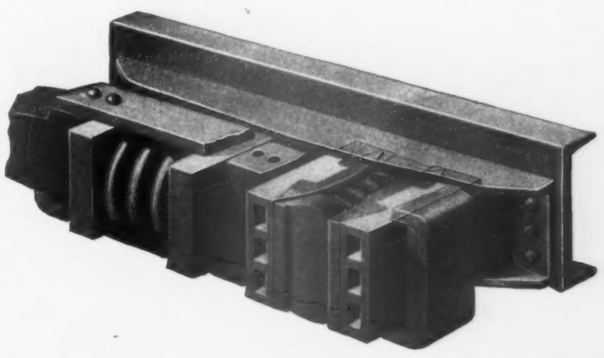
ENTERTAINMENT FOR SANTA FE EMPLOYEES.—With the completion of new buildings, every division headquarters of the Atchison, Topeka & Santa Fe Ry. between Chicago and Los Angeles is now equipped with a reading room for employees and an auditorium in which theatrical performances are given periodically, at the expense of the company. Thirty buildings are included in this entertainment system, where the men have the opportunity not only of receiving educational benefits, but of enjoying music and art. Four concert companies have been engaged to provide a series of entertainments in the various auditoriums and prominent lecturers will be engaged. The reading rooms thus far established are equipped with forty billiard tables and eighteen pianos, in addition to 40,000 volumes of reading matter.

GROWTH OF PENSION SYSTEMS.

With the beginning of the new year, 165,000 railroad employees have been added to the 500,000 in this country to whom pension plans already apply. This large increase is due to the action of the New York Central and Rock Island lines, which have announced the installation of pension departments.

The latest government report on the number of railroad employees puts the total for the country at 1,672,074. Of these approximately 665,000, or about 40 per cent., serve the roads which have pension systems. Companies that now bestow pensions on employees are the New York Central, the Rock Island, the Pennsylvania, the Buffalo, Rochester and Pittsburgh, the Chicago and North Western, the Illinois Central, the Santa Fe, the Union Pacific, the Southern Pacific and its affiliated lines, the Lackawanna, the Baltimore and Ohio, the Atlantic Coast Line, the Reading, and Jersey Central.

Under the plan of the railroads, the service of a man who is to receive a pension must be continuous. There are, however, certain exceptions to this. When an employee is disabled, for instance, or receives a leave of absence, or is suspended for discipline, or is temporarily laid off on account of a reduction in force, this is not considered a break in the continuity of service. Only by voluntarily leaving the company or by being discharged for good cause does an employee disqualify himself for a pension. One of the most important results of the pension policy is that it encourages long service and thereby increases efficiency.—*Railway World.*



PERSPECTIVE VIEW OF BUTLER FRICTION DRAFT GEAR WITH MINER ATTACHMENTS.

A CENT'S WORTH OF ELECTRICITY.

At the average rate for power paid by the ordinary consumer, says *Harper's Weekly,* a cent's worth of electricity will operate a 12-inch fan for 90 minutes.

Will operate a sewing-machine motor three hours.

Will keep a six-pound electric flatiron hot 15 minutes.

Will make four cups of coffee in an electric coffee percolator.

Will keep an 8-inch disk stove hot seven minutes, or long enough to cook a steak.

Will operate a luminous radiator eight minutes.

Will bring to a boil two quarts of water or operate the baby milk warmer twice.

Will make a Welsh rarebit in an electric chafing dish.

Will operate a 7-inch frying pan 12 minutes.

Will keep a heating pad hot two hours.

Will operate a griddle eight minutes.

Will run the electric broiler six minutes.

Will run a massage machine nearly four hours.

Will keep the dentist's electric hammer and drill going 90 minutes.

Will keep the foot warmer hot a quarter of an hour.

Will run an electric pianola one hour.

Will vulcanize a patch on an automobile tire.

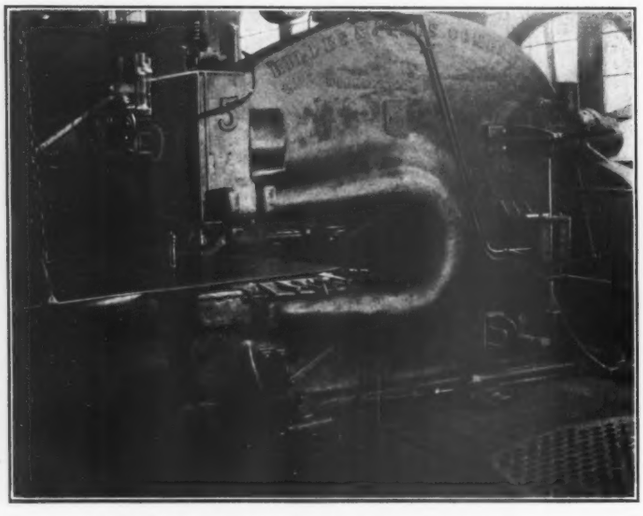
Will heat an electric curling iron once a day for two weeks.

AN ELECTRIC ATTCAHMENT FOR PUNCHES.

A device for use in connection with punches in the boiler shop, which not only saves the use of an extra man, but also permits much more accurate work on sheets of large size, is shown in the accompanying illustrations. This device was originally designed by the Pennsylvania Steel Company and used in its plant. With its permission the Pennsylvania Railroad is using it in their Altoona shops, where it has been applied to a No. 5 Hilles and Jones punching press. Three additional machines are now being equipped with it at the Juniata shops. The scheme used is to disconnect the foot connection to the clutch for throwing in the punch and operate it by means of a solenoid, the circuit to which is controlled by a push button in the top of the drift pin with which the boiler maker guides the sheet that is being punched. In this way a boiler maker and one helper are easily able to handle the largest flue sheets, since neither is required to move his body or make any change in position which might possibly affect the location of the sheet. After the sheet is located by the prick punch mark the pressure of the thumb on the button will throw the punch into operation, the sheet being held steady meanwhile.

The electric circuit required for an apparatus of this kind is shown in the diagram. It requires the use of two solenoids, one for the main operating device, having a pull of about 125 lbs. on a 120 volt circuit, and the other a contact making device, which is connected to the push button by a flexible cable and is on a 10 volt circuit.

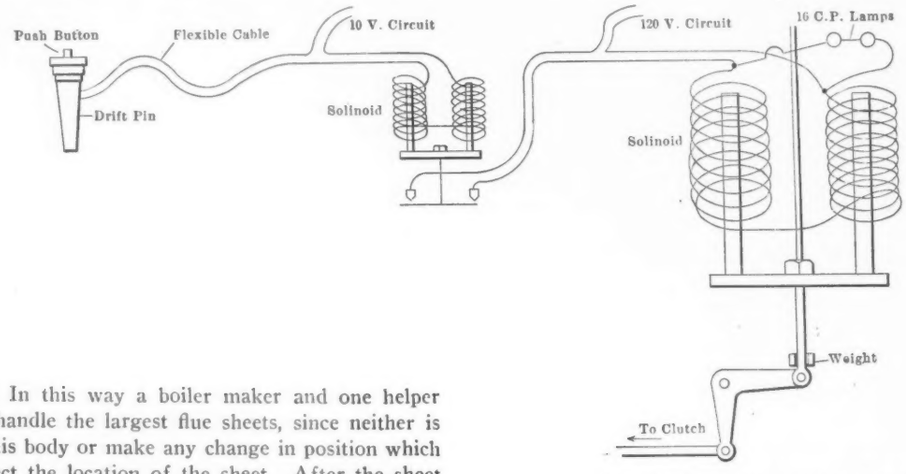
Experiments were first tried with the operating solenoid alone,



ELECTRIC ATTACHMENT ON PUNCHING MACHINE.

but it was often impossible to release the clutch quickly enough to prevent a double stroke.

The contact making bar of the small solenoid when drawn to place is sprung out of line, so that when the circuit is broken it will quickly release and will fly away from the contacts almost instantly. A weight is provided on the connection from the operating solenoid to assist in releasing the clutch. Two 16-candle power lamps are connected across the circuit, as is shown in the diagram, to take what is commonly known as the "kick-back" when the circuit is broken in the coils.



THE ELECTRIC CIRCUIT USED WITH THE SOLENOID ATTACHMENT.

CASE HARDENING.

In discussing this subject before the recent convention of the International Railroad Master Blacksmiths' Assn., H. Pentecost, of the American Locomotive Company, said:

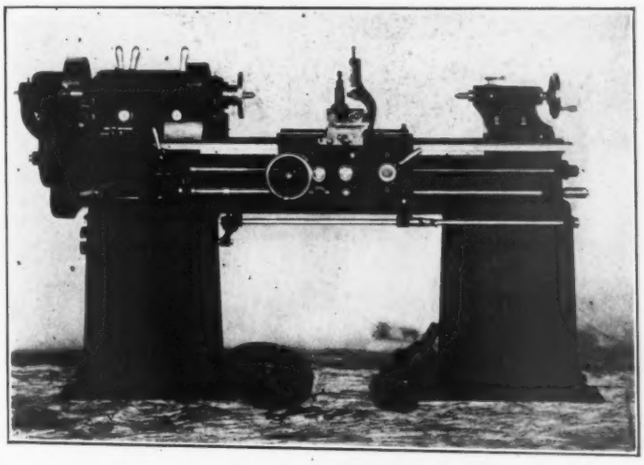
"We have quite an elaborate and up-to-date system of case hardening, having furnaces built especially for the work and men engaged for that purpose alone. We consider our case hardening about as good as can be done, as we have spared neither time nor expense to get good results. Our furnaces are built of special fire brick, each with two chambers or retorts made air tight, instead of boxes, as are generally used, with the fire space below between the two. These chambers are each 15 x 16 x 81 in.; large enough to take in anything on an engine that needs case hardening from a guide down to the smallest pin. These furnaces are full of flues that surround the chamber or retort where the case hardening is done, so as to keep it at an even heat all the time.

For fuel we use hard coke, as from our experience we get a more satisfactory heat than when using either coal or oil. For case hardening mixture we use charcoal, ground bone and potash, and mix them in the proportion of 200 lbs. charcoal with 50 lbs. each of ground bone and potash, renewing our mixture about every three or four days, according to the size and amount of work we are doing. At the present time we are case hardening guides 3 x 8 x 66 in., and can put in, using both chambers, two complete sets, besides other small pieces. We keep these guides in the furnace 20 hours, as we consider that none too long to make a good job. Steel guides, where we case-harden them, are left in the furnace from 8 to 10 hours. For iron links, 10 to 12 hours, and steel links 6 to 8 hours, according to the size. We have a jib crane with cable air hoist to lift the work out of the furnace, with tanks in the floor large and deep enough to take in all the furnace will hold. We keep these furnaces going all the time and have men taking care of them both day and night."

FOREST PRODUCTS IN 1908.—The total value of the forest products of the United States in 1908 is estimated to have been $1,050,000,000, a decrease of nearly 18 per cent. from the value in 1907, due chiefly to the business depression.

HIGH SPEED LATHE.

The geared head high speed engine lathe shown in the illustrations, and manufactured by the Prentice Bros. Company, Worcester, Mass, is the standard lathe redesigned throughout in much heavier construction and equipped with a new spindle reversing mechanism in the headstock. The design secures a single belt machine which simplifies the installation of a motor drive, if it should be desired, and at the same time contains in the machine itself all the elements except the motor and the



PRENTICE GEARED HEAD HIGH SPEED LATHE.

bracket upon which it is mounted. The greatest objection to lathes of the motor driven type—that of delay in securing them—is thus overcome.

To convert a standard belt driven machine to a motor driven one, it is only necessary to bolt a bracket on the rear side of the head end cabinet leg and belt from the motor direct to the driving pulley. Provision is made for adjusting the height of the bracket by a screw which acts as a belt tightener. Where the lathe is located underneath the line of shafting it is belted direct to the pulley on the headstock, without the intermediary of a countershaft. Eight changes of spindle speed are provided in the headstock.

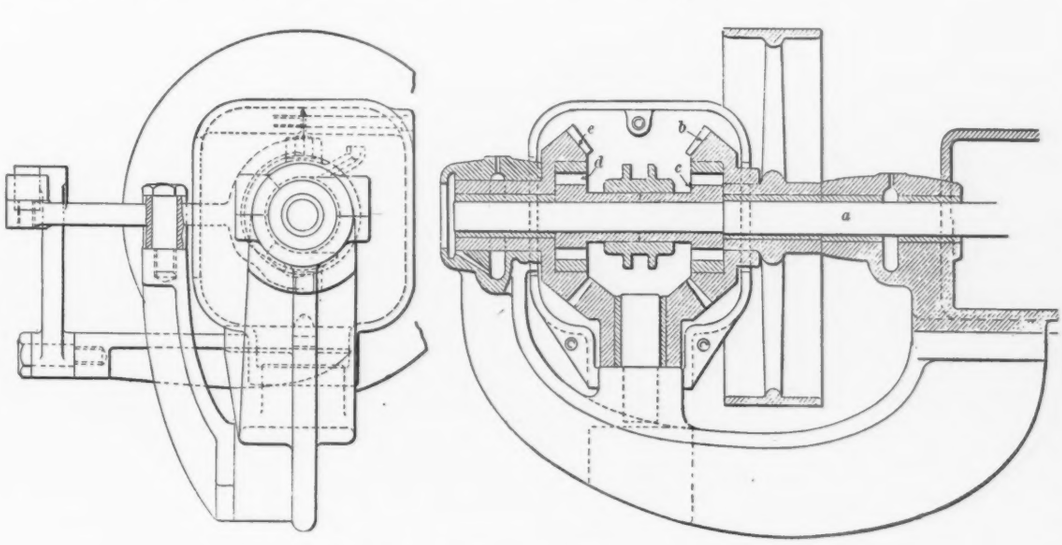
The spindle reversing mechanism, details of which are shown in the drawing, is located on the driving shaft *a* and comprises three bevel gears and two friction clutches, together with the levers for operating them. The controlling lever is located on the apron, with which it travels, so that the operator always has it immediately at hand for starting, stopping and reversing the spindle, no matter how long the lathe bed may be. The bevel gear *b* is mounted on the hub of the driving pulley, and when it is engaged by the friction *c*, the pulley and bevel gear are tight with the shaft and the spindle drives direct. The bevel gears then run idle and carry no load. To reverse the spindle the friction *d* is thrown into engagement with the bevel gear *e*, which is clutched to the shaft, and the drive is through the three bevel gears.

The distance between centers for a 6-ft. bed on the 12-in. lathe is 33 in., the swing over the ways is 14½ in. and over the compound rest 9½ in. The machine will cut 44 pitches of screw threads ranging from 4 to 60 threads. The net weight with a 6-ft. bed is 2,065 lbs.

A TRADE PAPER CONSOLIDATION.—Announcement is made of the consolidation of *Industrial Engineering*, heretofore published at Pittsburgh, and the *Engineering Digest*, New York. The offices will be at 220 Broadway, New York. Robert T. Kent, editor of *Industrial Engineering*, becomes managing editor of the consolidated magazine. Harwood Frost, who was the founder of the *Engineering Digest*, and one of its editors, will now devote himself entirely to the *Engineering News*.

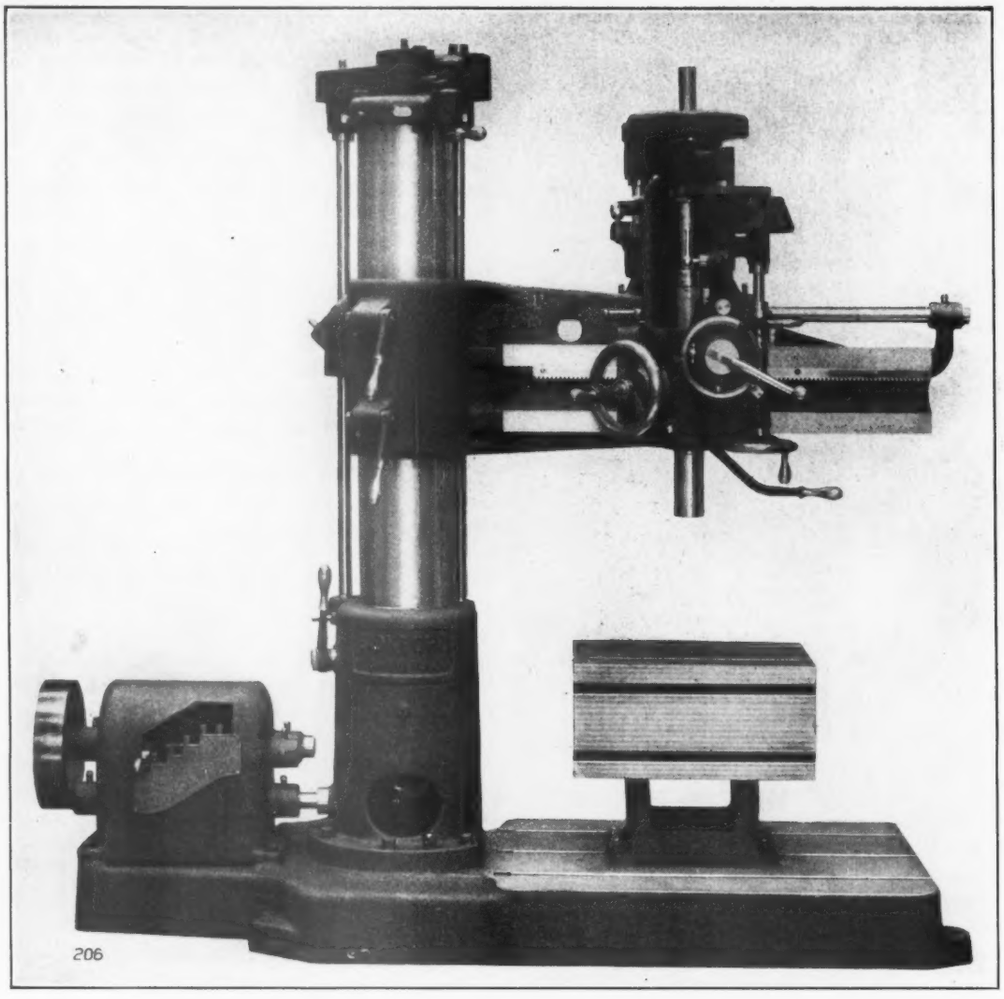
TOYS.—Few realize that more than $50,000,000 worth of toys have been imported into this country during the last decade. Despite this large importation the growth of the production of toys in the United States has been rapid in recent years, increasing from $1,500,000 in 1880 to $5,500,000 in 1905. The growth of toy making in this country has been chiefly in those which could be manufactured by machinery.—*American Machinist.*

AMOUNT OF OIL IN SATURATED WASTE.—There is a limit to the amount of oil which can be absorbed by the waste in the journal box. Careful experiment has shown that one pound of waste will absorb and hold four pints of oil. Any amount in excess of this will not remain in the waste, but will run down through it into the bottom of the box.—*William J. Walsh before the New England Railroad Club.*



DETAILS OF SPINDLE REVERSING DEVICE ON HIGH SPEED LATHE.

DOPE FOR PIPE THREADS.—In screwing pipe fittings together spread a thick mixture of graphite and oil on the threads. This will help make the joints steam or water tight. White lead is used when the pipe is not to be taken apart again. It hardens, while the graphite does not, and makes it almost impossible to unscrew the pipe fittings when they have been connected for a long time.—*Gas Review.*



CINCINNATI-BICKFORD IMPROVED RADIAL DRILL.

IMPROVED RADIAL DRILL.

The smallest sizes of the line of radial drills manufactured by the Cincinnati-Bickford Tool Company, Cincinnati, Ohio, have recently been redesigned. This includes the 2½, 3 and 3½ foot drills. The improvements which have been made add greatly to their efficiency. The design has a column extending to the top of the sleeve, ribbed internally to furnish a high degree of stiffness. It is mounted on a base which has been considerably strengthened at the point where the flange is bolted down. The ring that supports the elevating screw and takes the weight of the arm itself, is now supported on ball bearings, greatly reducing the force required to swing the arm. The pipe section of the arm has been retained, giving a high degree of strength and stiffness.

The power of the drive has been augmented by putting on a larger driving pulley, allowing a greater belt capacity. The gear box allows changes to be made while the machine is running at a high speed, by the simple changing of the lever from one notch to the other. This may be done without taking special precaution to prevent breakages. The settings for the different diameters of drills are given below the notches in which the change gear lever rests. Gears subjected to hard service are of hardened steel. The bevel gears transmitting the power to the column have been increased in size.

The back gears are located in the head. They are of simple construction, consisting of three gears and a clutch, and may be engaged or disengaged while running. The clutch is made of high-grade carbon steel and has hardened teeth. The gear-box and back-gears provide twelve changes of speed, ranging from 38 to 356 revolutions per minute; they are correct for a cutting speed of 35 feet per minute for drills from ⅜ inch to 3½ inches in diameter.

The reversing clutch, the lever for which may be seen extending below the head, is expanded by a plunger and toggle-joint arrangement, whereby its capacity is increased many times over that of the wedge type of clutch formerly used. Adjusting screws permit the friction rings to be set to any tension desired. The reversing lever is employed for starting and stopping the machine as well, being within convenient reach of the operator.

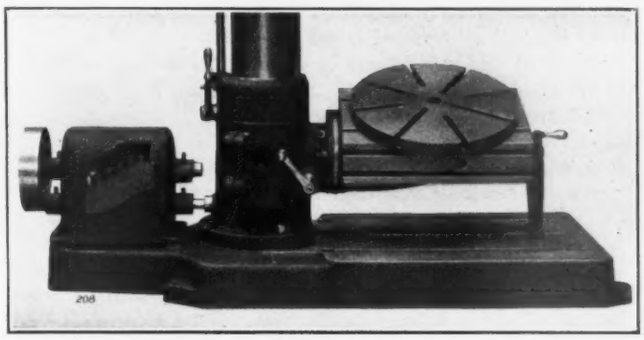
The feed change device operates by means of a ball handle controlling a driving key mechanism. This gives four changes ranging from 0.008 to 0.020 inch advance per revolution of the spindle. Any one of these feeds is instantly available. The feed clutch is made of hardened steel. The thrust of the feed worm is taken on a ball bearing instead of on a fiber washer. The spindle sleeve also exerts its pressure on the spindle through a ball thrust bearing, reducing the power to run the machine nearly 22 per cent. This, with the increased diameter of the driving pulley, makes the machine capable of doing much heavier work than formerly.

The quick return handle on the feed pinion shaft is provided with a toggle-joint type of adjustable clutch. This requires but a slight force to engage it, thereby avoiding the possibility of throwing the handle out of position by a sudden violent effort. Instead of graduating the spindle sleeve as formerly, depths are now read from a dial permanently located on the quick return head on the feed pinion shaft. The automatic stop is also made a part of the depth gauge, and it may be set in position instantly without requiring trial cuts or measurements.

The guide on the top of the arm for the adjustment of the

head is made flat instead of angular, thereby allowing the head to move more easily, and minimizing the tendency for it to rock on the arm while the machine is in operation. The head clamping device has the important feature of tightening the gib in the head instead of lifting it away from it. This gib is now made taper instead of flat and is fitted with an improved adjusting device which eliminates the undesirable feature of having the weight of the head rest on the point of two screws. It also prevents the possibility of any end play.

Three forms of table are provided. In the general view of the machine the box table is shown clamped on the base of



UNIVERSAL SWINGING, TILTING AND ROTATING WORK TABLE.

the machine, and provided with working surfaces on both sides as well as on the top. One of the illustrations shows a swiveling table provided with a wormwheel adjustment for setting it to any angle about a horizontal axis, the angle being indicated by a graduated ring of large diameter; a dowel is provided for locating it in the horizontal position. This design is also furnished, if desired, as a plain swinging table, without the swiveling attachment. The round work-table shown is a supplementary device which may be placed on the box, swinging or swiveling tables.

Special attention is directed to the very complete set of gear guards provided. This is in line with the modern tendency of safeguarding the workman. It has other advantages as well, however. It protects the gears from accidents, such as are particularly likely to occur in shops having traveling cranes. It prevents the throwing of oil over the clothes of the operator; it also adds greatly to the appearance of the machine.

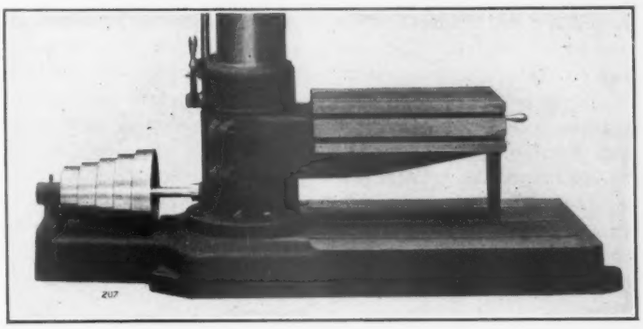
THE IDEAL LOCOMOTIVE.

The "ideal locomotive" has received considerable discussion in the columns of *The Engineer* (London) during the past year. The result is summed up in a recent editorial in that publication, from which the following extract has been taken:

"The locomotive is the most remarkable machine ever constructed to develop power. No other motor works under the same varying conditions. At one moment we find it developing maximum horse-power while making, perhaps, ninety or one hundred revolutions per minute. Soon afterwards it is again giving out maximum power, while its cranks are turning round 300 or 350 times in a minute. It is a slow-speed engine. It is a high-speed engine. It is an all and every speed engine; and it is expected to be economical, no matter what the average cylinder pressures may be. The resistance which it has to overcome varies from minute to minute. It must behave well as a vehicle. It must be beyond all other machines trustworthy. With heavy, fast, long-run trains it has to work within an inch of its life for hours together. There is nothing like it in the world. The motor car has no such difficulties to contend against. If it has to climb a hill the gear is changed. There is no change gear for the railway engine. The torpedo destroyer's engines are to a certain extent like the locomotive; but the occasions when full power is wanted and put forth are quite rare. With the locomotive maximum power is the rule, not the exception.

"It ought to be obvious that to get an ideal engine under such conditions is from one point of view hopeless; from another we have it already. Every locomotive is an ideal machine. All depends on the concept formed, on the standard of excellence to which the ideal engine must conform. As we have already said, each man will shape his own ideal, or will reject the notion as impracticable. So far no one has attempted to do more than say that some given type will be better than other types; but the so-called proof is seldom convincing, or, if convincing, satisfying. Take, for example, compounding. It would be quite out of place to say anything here about the merits or demerits of the system from a theoretical point of view. It is certain, however, that the principle has been very fully and carefully tried for a great many years on many of our great railways under the most varying conditions, and on none of them has it retained its position. It is merely wild hitting in the dark to say that its unpopularity is due to prejudice. The truth is that the only possible advantage the compound has over the non-compound is fuel economy; but as we have often explained, the saving must be a very large one if it is great enough to counteract contingent disadvantages. So far as we are aware, no one attempts to say that under favorable conditions the compound will not save coal. But the facts go to show either that these conditions are not present on British railways to any notable extent; or else that the expenses of maintenance and so forth are so great that compounding is not worth having. It is improbable that any of our correspondents has had recent running shed experience, or has received drivers' and examiners' weekly and daily reports. These things do not reach the public, but they represent very special and valuable information, enabling locomotive superintendents to decide on the perpetuation or rejection of any particular system of construction or method of working.

"We do not, of course, wish it to be supposed that we think that finality has been reached, and that no further developments or improvements are possible. Far from that, we believe that they will be made; but it is not necessary that they shall be



PLAIN SWINGING TABLE ON RADIAL DRILL.

confined to augmenting economy in fuel. But even in that progress will take place. Superheating has for some time past been tried on a scale and with a completeness never before attempted in this country. Of the economy secured there is no question. Nothing but the lapse of time can tell us whether the price paid for the saving is or is not too great."

THE TUNGSTEN LAMP.—All previous developments of incandescent lamps have told of progress, but the introduction of the tungsten lamp means a *revolution* in lighting work. Reaching, as it does, a standard three times higher than the present incandescent lamps, the tungsten lamp surpasses all other forms of lamps in efficiency—the arc and the Nernst are all outclassed, with the possible exception of the flaming arc and some forms of vapor tube lighting. By means of its numerous and well-known advantages the incandescent lamp has maintained itself in the field in competition with other illuminants, and now that it is able to match them in efficiency, there will probably be no limit to its use except the ability of the public service corporations to supply service therefor.—*F. W. Willcox before The Engineers' Club of Philadelphia.*

FIRST SOLID STEEL PASSENGER TRAIN, COMPOSED OF DAY COACHES, DINING CAR, AND PULLMANS, OPERATED BY THE PENNSYLVANIA RAILROAD COMPANY, AND THE FIRST SUCH TRAIN EVER OPERATED ANYWHERE.

STEEL PASSENGER CARS ON THE PENNSYLVANIA.

The Pennsylvania Railroad in November, 1906, ordered 100 all-steel passenger cars. Since that time additional orders have been placed and there are now in service on the company's lines 245 coaches, 10 dining cars, 21 combination passenger and baggage cars, 29 baggage cars, 18 postal cars, and one company car; a total of 324 cars. In course of construction there are 140 coaches, 34 dining cars, 48 combination passenger and baggage cars, 4 baggage cars, 42 postal cars, 27 mail storage cars, and 11 baggage and mail cars.

The Pullman Company, at the instance of the Pennsylvania Railroad, has for the past four years been at work designing all-steel parlor and sleeping cars. Some 500 such cars are shortly to be completed and placed in service on the Pennsylvania Railroad.

With the all-steel passenger equipment now in service, or on order, and some 250 steel cars to be ordered on the 1910 passenger equipment programme, the Pennsylvania Railroad will, in a short time, have in service about 900 of its own steel passenger cars, and 500 steel Pullman cars.

BOOKS.

"Fuel Tests with House Heating Boilers," by J. M. Snodgrass, is issued by the Engineering Experiment Station of the University of Illinois as Bulletin No. 31. This bulletin is designed for the technical rather than for the general reader. It will be of interest to producers of fuel for domestic heating and to those who are concerned with the design and method of house-heating apparatus. Comparatively few tests have hitherto been made in connection with house-heating apparatus, and the results of this bulletin constitute a timely definition of its efficiency. The bulletin is intended to constitute the first of a series dealing with fuels and apparatus used for house-heating or other domestic purposes. Copies may be obtained gratis upon application to W. F. M. Gross, director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

"Tests of Tungsten Lamps," by T. H. Amrine and A. Guell, issued as Bulletin No. 33 of the Engineering Experiment Station of the University of Illinois, presents the results of tests upon tungsten lamps of the 25-watt size. Of the three kinds of lamps tested, one kind was of American manufacture with filaments made by the paste process; the other two kinds were of German manufacture, with filaments made by the colloid and deposition processes. Each type of lamp had a different scheme of filament mounting.

From these tests it is shown that:

(1) When the lamps are subject to vibration, the life depends to a great extent upon the scheme of filament mounting, so that a lamp having its filaments mounted in such a manner that they are never under tension, gives a much better life, when subject to vibration, than one having tightly strung filaments.

(2) After burning 2,000 hours under good conditions of operation, the average candle-power of the filaments made by the paste process, decreased to 88 per cent.; of the filaments made by the deposition process to 89 per cent.; and of those made by the colloid process to 77 per cent. of the initial value.

(3) The paste filament lamp, with loosely strung filaments, gives the longest life under both good and poor conditions of operation.

(4) The frequent breakage of the filaments during shipment and ordinary handling, and the early blackening of the bulbs, common in the early tungsten lamps, seem to have been overcome in all three types of lamps tested.

Copies of this bulletin may be obtained gratis upon application to W. F. M. Goss, director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

Proceedings of the Traveling Engineers' Association. Seventeenth Annual Convention held at Denver, Colorado, Sept., 1909. Leather, 374 pages, 6 by 9 in. Secretary W. O. Thompson, 820 Elmwood ave., Buffalo, N. Y.

The proceedings of this association should be studied by those who are in charge of the compiling and arranging of the proceedings of railway clubs and associations. Well printed, neatly and carefully arranged and with first-class half-tones and line drawings, it forms quite a contrast to the average book of this kind. Among the principal reports and papers presented and discussed were the following: The most economical method of maintaining engine equipments; fuel economy (report and discussion cover over 60 pages); proper method of handling air brakes on long trains to insure smooth service (60 pages); boiler check valves and feed water delivery—does their location and arrangement affect the working of the injector, steaming of the boiler and formation of scale; piping arrangement between engine and tender for steam, air and water; modern methods of cleaning ash pans; function of the parts of Walschaert valve gear, method of procedure in failure or breakdowns on simple and compound engines, including Mallet type; electric locomotives; what can be done to obviate tender derailments.

"The Occluded Gases in Coal," by S. W. Parr and Perry Barker, issued as Bulletin 32 of the Engineering Experiment Station, University of Illinois, contains the results of researches to determine the behavior of coal upon exposure to the atmosphere with reference to the gases normally contained by it in the mine. The investigation is a part of a study which is being made by the Engineering Experiment Station relating to the deterioration and weathering of coal as well as its spontaneous combustion.

As a result of these experiments, it appears (1) that freshly mined coal when subjected to a vacuum yields an appreciable percentage of combustible hydrocarbons; (2) that the escape of these combustible hydrocarbons takes place slowly in coal exposed to ordinary atmospheric conditions, and is almost entirely suppressed when submerged in water; (3) that the avidity of coal for oxygen is so marked that a sample in an air-tight jar with a large volume of air quickly exhausts the air completely of its oxygen; and this experiment may be repeated a number of times without appreciably lessening the avidity of the coal for oxygen; (4) a comparatively small amount of this oxygen shows itself as carbon dioxide of water, but is seemingly more largely involved in the formation of organic acids, such as humic acid, etc.; (5) the finely divided coal is more active in these processes than the coarse coal. On the whole, these experiments, as above summarized, afford positive indications as to some of the underlying causes of the heating and spontaneous combustion of coal in storage. Copies of this bulletin may be obtained upon application to W. F. M. Goss, director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

Railways of China.—China possesses 6,300 miles of railways, of which only 1,930 are managed by the Chinese. The

management of the remaining 4,370 miles is divided among six foreign powers, as follows: Russians manage 1,077 miles, Belgians 903 miles, Japanese 702 miles, Germans 684 miles, English 608 miles, and Frenchmen 400 miles. When the railways now being laid down in China are finished, the total length of China's railway system will amount to 8,000 miles.—*The Engineer (London)*.

RAILWAY CLUBS.

Canadian Railway Club (Montreal).—At the meeting on Tuesday, March 1, G. I. Evans, chief draftsman of the motive power department of the Canadian Pacific Railway, at Montreal, will present a paper entitled "An Experimental Mallet Articulated Locomotive." Secretary, James Powell, P. O. Box 7, St. Lambert, near Montreal, Can.

Central Railway Club (Buffalo).—At the meeting on Friday, March 11th, J. R. Sloan, general electrician of the Pennsylvania Railroad at Altoona, will read a paper on "Electric Car Lighting." Secretary, H. D. Vought, 95 Liberty street, New York City.

New England Railroad Club (Boston).—On Tuesday evening, March 8th, there will be a discussion on the "M. C. B. Rules of Interchange." This is also the annual meeting of the club. It will be held at the Copley Square Hotel; dinner will be served at 6:30 P. M. Secretary, George H. Frazier, 10 Oliver street, Boston, Mass.

New York Railroad Club.—Friday evening, March 18th, will be the "Annual Electric Night," at which time the report on "Electrification" will be presented by a standing committee appointed some time ago. Secretary, H. D. Vought, 95 Liberty street, New York City.

Railway Club of Pittsburgh.—The standing committee on the M. C. B. rules of interchange will make its report at the next meeting, Friday, March 25th. Secretary, C. W. Alleman, P. & L. E. R. R., Pittsburgh, Pa.

Western Railway Club (Chicago).—At the March meeting, Tuesday, the fifteenth, the committee on "Revision of the Rules of Interchange" will present a report. Prof. H. Wade Hibbard of the University of Missouri will also read a paper, the subject of which has not yet been announced. Secretary, Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

Other Club Meetings.—Iowa (Des Moines), Friday, March 11. Northern (Duluth), Saturday, March 26. Richmond, Monday, March 14. St. Louis, Friday, March 11. Western Canada (Winnipeg, Man.), Monday, March 14.

ELIMINATION OF GRADE CROSSINGS.—While invariably avoiding grade crossings on new and revised construction work, the Pennsylvania Railroad has, in the last ten years, been eliminating all crossings at grade as rapidly as practicable. A compilation for the period since January 1, 1900, shows that 673 grade crossings have been removed on the lines of the system east of Pittsburgh and Erie. These figures are of record of September 1, 1909, and do not include the ten crossings to be eliminated by the change of line to be made through Bristol, Pa., on the New York Division. On the lines of heaviest traffic between New York and Washington and Philadelphia and Pittsburgh, the company has abolished 256 public grade crossings in the past ten years. The 774 public crossings remaining are scattered over 574 miles of road, and are, with a few exceptions, at unfrequented highways where traffic is inconsiderable. There have also been removed, in addition to the 256 public crossings, 129 private crossings at grade.

PERSONALS.

C. H. Kenzel has been appointed assistant purchasing agent of the Elgin, Joliet & Eastern, with office at Chicago.

J. C. Miller, district master mechanic of the Chicago, Milwaukee & St. Paul, with office at Milwaukee, Wis., has retired.

E. C. Anderson has been appointed mechanical engineer of the Colorado & Southern Ry., with headquarters at Denver, Colo.

C. H. Montague has been appointed superintendent of motive power of the St. Paul & Des Moines, with office at Des Moines, Iowa.

D. H. Speakman, master mechanic on the Rock Island Lines, has been transferred to the Nebraska and Colorado divisions at Goodland, Kan.

W. J. Bohan, electrical engineer of the Northern Pacific at St. Paul, Minn., has been appointed mechanical engineer, with office at St. Paul.

Henry Mel, material agent of the National Railways of Mexico at Beaumont, Tex., has been appointed assistant purchasing agent, with office at Beaumont.

Richard Lanham, road foreman of engines of the St. Louis, Iron Mountain & Southern, at De Soto, Mo., has been appointed a master mechanic, with office at Paragould, Ark.

G. G. Gilpin has been appointed chief draftsman of the Chicago, Burlington & Quincy, to succeed E. C. Anderson, who has been appointed mechanical engineer of the Colorado & Southern Ry.

W. R. Thomas, road foreman of engines of the Cincinnati, New Orleans & Texas Pacific, has been promoted to general foreman of the mechanical and car departments, with office at Ludlow, Ky.

R. L. Stewart, master mechanic of the Kansas City terminal and the St. Louis division of the Rock Island Lines at Armourdale, Kan., has been transferred to the Missouri division, with office at Trenton, Mo.

H. J. Osborne, master mechanic of the Nebraska and Colorado divisions of the Rock Island Lines at Goodland, Kan., has been transferred to the Iowa and Des Moines Valley divisions at Valley Junction, Iowa.

W. Alexander, assistant district master mechanic of the Chicago, Milwaukee & St. Paul at Milwaukee, Wis., has been appointed district master mechanic, with office at Milwaukee, succeeding J. C. Miller, resigned.

J. F. Sheahan, master mechanic of the Southern Railway, at Knoxville, Tenn., has been appointed master mechanic of the International & Great Northern, with office at Palestine, Tex., succeeding F. S. Anthony, promoted.

James T. Wallis, superintendent of motive power on the Erie division of the Pennsylvania Railroad and of the Northern Central, has been appointed acting superintendent of the West Jersey & Seashore, also of the Philadelphia & Camden Ferry, with office at Camden, N. J., succeeding D. H. Lovell, granted leave of absence.

M. H. Wickhorst, engineer of tests of the Chicago, Burlington & Quincy, with office at Aurora, Ill., has been granted a leave of absence for one year to become chief chemist in charge of rail tests by the American Railway Engineering and Maintenance of Way Association. W. A. Derby succeeds Mr. Wickhorst.

W. Hamilton has been appointed master mechanic of the Western division of the Grand Trunk Railway System, with headquarters at Battle Creek, Mich., in place of E. D. Jameson, who has been assigned to other duties.

L. A. Richardson, master mechanic of the Missouri division of the Rock Island Lines at Trenton, Mo., has been appointed master mechanic of the Chicago terminal and the Illinois division, with office at Chicago, succeeding D. H. Speakman, transferred.

N. N. Boyden, master mechanic of the Southern Railway at Atlanta, Ga., has been transferred to Knoxville, Tenn. George Akans, master mechanic at Birmingham, Ala., succeeds Mr. Boyden; E. M. Sweetman, master mechanic at Sheffield, Ala., succeeds Mr. Akans, and Frank Johnson, general foreman of locomotive repairs at Knoxville, succeeds Mr. Sweetman.

Hugh M. Wilson, vice-president of the Barney & Smith Car Company, and well known to our readers as the publisher of the *Railway Age*, has been elected vice-president of the McGraw Publishing Company. Mr. Wilson succeeds Jas. M. Wakeman, who has been an important factor in the success of the McGraw Publishing Company with which he has been connected since its formation.

J. H. Guess, purchasing and fuel agent of the National Railways of Mexico at City of Mexico, Mex., has been appointed general purchasing agent of the Mexican International and the Interoceanic, with office at City of Mexico, and his former title has been abolished. A. Herrera has been appointed purchasing agent, with office at City of Mexico, succeeding Carl H. Smith, resigned.

J. E. Buker, having resigned as superintendent of car department of the Illinois Central, the Indianapolis Southern and the Yazoo & Mississippi Valley, to become first vice-president of the Chicago Car Heating Co., his former position has been abolished, and the duties of this position have been assumed by the superintendent of machinery. The position of J. M. Borrowdale, assistant superintendent car department, has also been abolished and Mr. Borrowdale will report to the superintendent of machinery and perform such duties as may be assigned to him.

H. A. Fabian, assistant to the president of the New York, New Haven & Hartford and the Central of New England at New Haven, Conn., has been appointed to the new position of manager of purchases and supplies of the New York, New Haven & Hartford and the Boston & Maine, with office at Boston, Mass., effective March 1. He also holds the same position on the controlled lines of the New York, New Haven & Hartford, namely, Central New England, New England Navigation Co. and the street railways, the Connecticut Co., New York & Stamford Ry. Co., Rhode Island Co. and the Housatonic Power Co., as well as for the controlled lines of the Boston & Maine, namely, Maine Central, Washington County and the Somerset Railway Co.

William Buchanan, superintendent of motive power of the New York Central & Hudson River Railroad for eighteen years up to 1899, died January 20, at his home in South Norwalk, Conn. Mr. Buchanan was born in Scotland, March 6, 1830. He came to this country when a boy and began railway work in the summer of 1847. In 1849 he was an apprentice in the shops of the Albany & Schenectady, but soon went to the Hudson River road, where he remained the rest of his active life. For three years he was machinist and shop foreman. In 1853 he became master mechanic, and in April, 1880, was made superintendent of motive power of the Hudson River and Harlem divisions. From April, 1881, to his resignation in May, 1899, he was superintendent of motive power and rolling stock of the entire system—the New York Central & Hudson River, the West Shore, the Rome, Watertown & Ogdensburg and the Dunkirk, Allegheny Valley & Pittsburgh.

CATALOGS.

LEACH SANDERS.—The various styles of this well known device are described in a catalog issued by the American Locomotive Sander Company, Thirteenth and Hamilton streets, Philadelphia, Pa.

STEEL TRUCK SIDE FRAME.—The advantages of the Buhoup steel truck side frame, manufactured by the McConway & Torley Company, Pittsburgh, Pa., are briefly stated in a neatly arranged pamphlet recently issued by them.

VANADIUM METALS IN RAILROAD SERVICE.—In a pamphlet under this title, published by the Vanadium Metals Company, Frick Building, Pittsburgh, Pa., the properties, the uses and the advantages of "Victor Vanadium Bronze" are discussed.

VERTICAL BORING MILLS.—The friction headstock and lever control of the Gisholt vertical boring mills, manufactured by the Gisholt Machine Company, Madison, Wis., is described in detail on a sheet intended for insertion in the loose-leaf binder furnished by that company.

THE JANNEY X COUPLER.—This improved coupler complies with all the requirements and also the recommendations of the Master Car Builders' Association, and meets every requirement of the safety appliance law. It is manufactured by the McConway & Torley Company of Pittsburgh, Pa., and is described in a pamphlet issued by that company.

TURRET MACHINERY—A 300-page, 4½ by 7¼ in., catalog on this subject has been received from Bardons & Oliver, Cleveland, Ohio. It consists of seven sections as follows: Part I, Turret lathes mounted on column with oil pan and oil pump; Part II, Turret lathes mounted on legs for working metals not requiring the use of a lubricant; Part III, Parts and attachments; Part IV, Tools; Part V, Illustrations and names of parts for use in ordering repairs; Part VI, Reference tables and data; Part VII, Index, etc.

THE DRAFT GEAR UP-TO-DATE.—The Union Draft Gear Company of Chicago, Ill., has published a booklet under this title, edited and arranged by Norman F. Rehm. It considers the development of the draft gear and discusses the limitations of the spring gears and the advantages and the necessity of using friction draft gears. The proper principles upon which the successful friction gear should be designed are stated. The booklet closes with an illustrated description of how to assemble the Cardwell friction draft gear.

TRAIN RESISTANCE.—The American Locomotive Company has recently issued Bulletin No. 1001, entitled "Train Resistance," which is a condensed and yet very complete discussion of this subject. The figures and formulæ given in the bulletin are based on a careful and analytical study of the most recent and exhaustive dynamometer tests and data obtained from the best authorities, and are probably more nearly correct for average American railroad conditions than any other like figures at present in use. The data is arranged in the form of tables and charts for convenient use, and the bulletin is one which will be of great practical value to railway officials.

NOTES

BURTON W. MUDGE & COMPANY.—This company of Chicago announces that Otto P. Hennig has been appointed sales manager in charge of sales, advertising and purchasing.

THE TITAN STEEL CASTING COMPANY, Newark, N. J., has purchased the business of Benjamin Atha & Company and will continue to operate the plant as in the past, giving special attention to the production of cast steel bolsters, manganese steel railway motor gears and pinions and other car and locomotive castings. The following are the officers of the new company: Benjamin Atha, president; Louis A. Shepard, vice-president and general manager; Henry G. Atha, treasurer, and C. W. Owston, Jr., secretary.

SIMPLEX RAILWAY APPLIANCE COMPANY.—In the suit of the Simplex Railway Appliance Company against the Pressed Steel Car Company for infringement of Simplex bolster patents, Judge Hazel, of the United States Circuit Court for the Southern District of New York, has just decided in favor of the Simplex Company, and has ordered an injunction against the Pressed Steel Car Company to restrain it from further use of the device, and has also ordered an accounting, with costs, in favor of the Simplex Company.

DEARBORN DRUG & CHEMICAL WORKS.—On May first this company will move their general offices and chemical laboratories from the Postal Telegraph Building, where they have been located since the organization of the company more than twenty years ago, to the new McCormick Building, on Michigan avenue and Van Buren street. The extensive growth of the business of the company has made necessary this removal to its new home, where the general offices and laboratories will occupy the greater portion of the top floor of one of the finest office buildings in Chicago. The Dearborn Company will have the entire frontage on Michigan avenue with a total floor space of more than 5,000 square feet.

READVILLE LOCOMOTIVE SHOP—NEW YORK, NEW HAVEN AND HARTFORD RAILROAD

A GENERAL DESCRIPTION OF THE ARRANGEMENT AND CONSTRUCTION OF THE BUILDINGS, GROUPING AND LOCATION OF THE MACHINE TOOLS AND METHODS OF OPERATION AT ONE OF THE MOST EFFICIENT RAILROAD SHOPS IN THE COUNTRY.

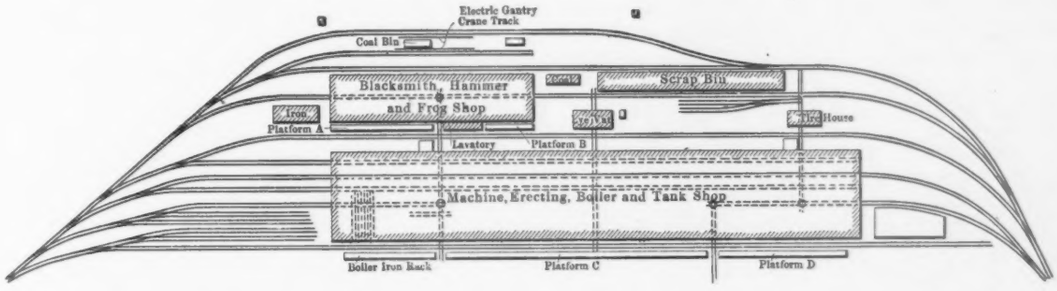
For the purpose of taking care of the heavy repairs on its steam locomotives the New York, New Haven & Hartford Railroad about three years ago put into operation a new and complete locomotive shop at Readville, a suburb of Boston, Mass. This shop is located adjacent to the large and thoroughly equipped passenger and freight car shops* that were constructed a few years previous and although the embankment of the Midland Division separates the two departments, it in no way interfering with the operation of the whole shop as a unit, under the direction of the shop superintendent. Undercrossings through the embankment at convenient points provide ample means of communication between the two shops.

One of the illustrations shows the general arrangement of the locomotive shop plant, which it will be seen consists of but two structures of large size. One very large building, measuring 150 x 904 ft. 6 in. outside dimensions, is used for the machine, erecting, boiler and tank shops. The other structure, 80 x 354 ft. 6 in. outside dimensions, houses the blacksmith, hammer and frog and switch shops.

The larger structure is parallel and adjacent to the embankment of the Midland Division, and the smaller is located just beyond and parallel with this building. There are also a number of smaller structures included in the arrangement, one being a storage for bar iron stock, located just outside of the blacksmith shop; another for coal, located at the opposite end of the blacksmith shop; the cleaning house enclosing the lye vats, opposite the center of the erecting shop; a tire house near one end of the erecting shop and the enclosed scrap bins located at a convenient point for access from both shops as well as the yard.

It will be noticed in the general layout that there are a row of platforms just outside of the machine shop building. These are of concrete about 3 ft. above grade and on them are stored boiler iron, flanging frames, tubes, castings and other rough stock for use in these shops. Their height is such as to bring them level with the deck of a push car and heavy parts are loaded by rolling or skidding. They extend the full length of the building, being divided into three parts by two passageways. Two similar platforms for storage of the material used in the blacksmith shop are located just outside of that building. The material on these platforms is storehouse stock and is under the supervision of a storehouse employee, who issues it only upon requisition from a foreman having the authority to sign requisitions. The stock is arranged, as far as possible, so as to be opposite the section of the machine shop that is to use it, making the transporting of rough castings and other material as convenient as possible. The same features apply also to the iron stock structure, where all bar iron is maintained as storehouse stock. The arrangement of this building will be described later.

Stock for use in the locomotive department, with the exception of tires, wheel centers, cylinders and other heavy parts that require a crane, is unloaded direct from cars on the track alongside the platforms and does not go to the general storehouse. The heavy castings and forgings are stored under the craneway near the tirehouse.



GENERAL ARRANGEMENT OF THE BUILDING AND TRACKS OF THE LOCOMOTIVE SHOPS AT READVILLE, MASS.—NEW YORK, NEW HAVEN AND HARTFORD RAILROAD.

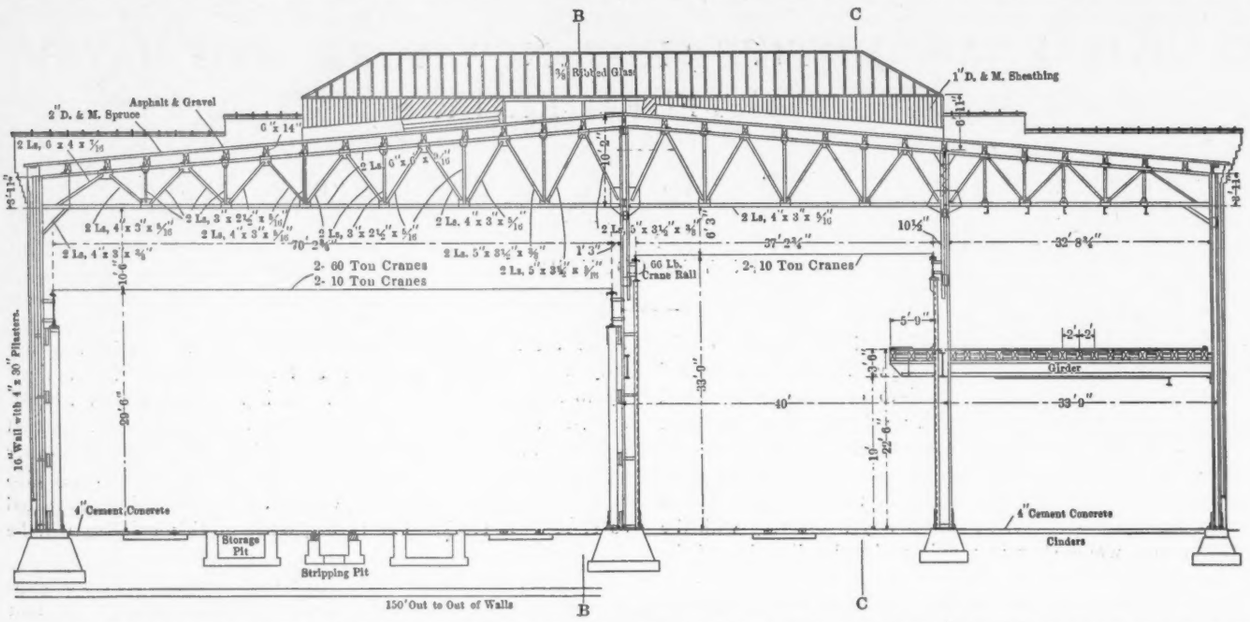
MAIN LOCOMOTIVE SHOP.

A remarkably convenient, open and well lighted structure, encloses the erecting, machine, flue, boiler and tank shops. The steel frame work is shown in detail in the illustrations and is entirely self-supporting. It is enclosed by a brick wall resting on a concrete foundation, continued 5 ft. above grade to the level of the window sills, the sills being formed in concrete. The side walls have practically 50 per cent. lighting area, which, in connection with the skylights, gives unusually good and well distributed natural light throughout the structure.

The building is divided in half longitudinally by the row of columns which support the center of the roof truss, and also carry the runway for the machine shop cranes. Adjacent to these are columns that support the runways for the erecting cranes. The southern half of the building is given over very largely to the erecting work, but also includes the driving wheel work and the tank repairs. Three longitudinal tracks run the full length of this section, and between them are storage pits covered with a removable wooden floor in small sections.

The other half of the building is divided into practically two equal parts by the row of columns which carry the other runway of the 10-ton cranes that serve the heavy machines located in the bay next to the erecting shop. The bay lying between these columns and the outer wall has a gallery which is used for lighter machine work, as is shown on the accompanying insert. This extends about 6 ft. beyond the columns. Below the gallery

* See AMERICAN ENGINEER, February and March, 1901.



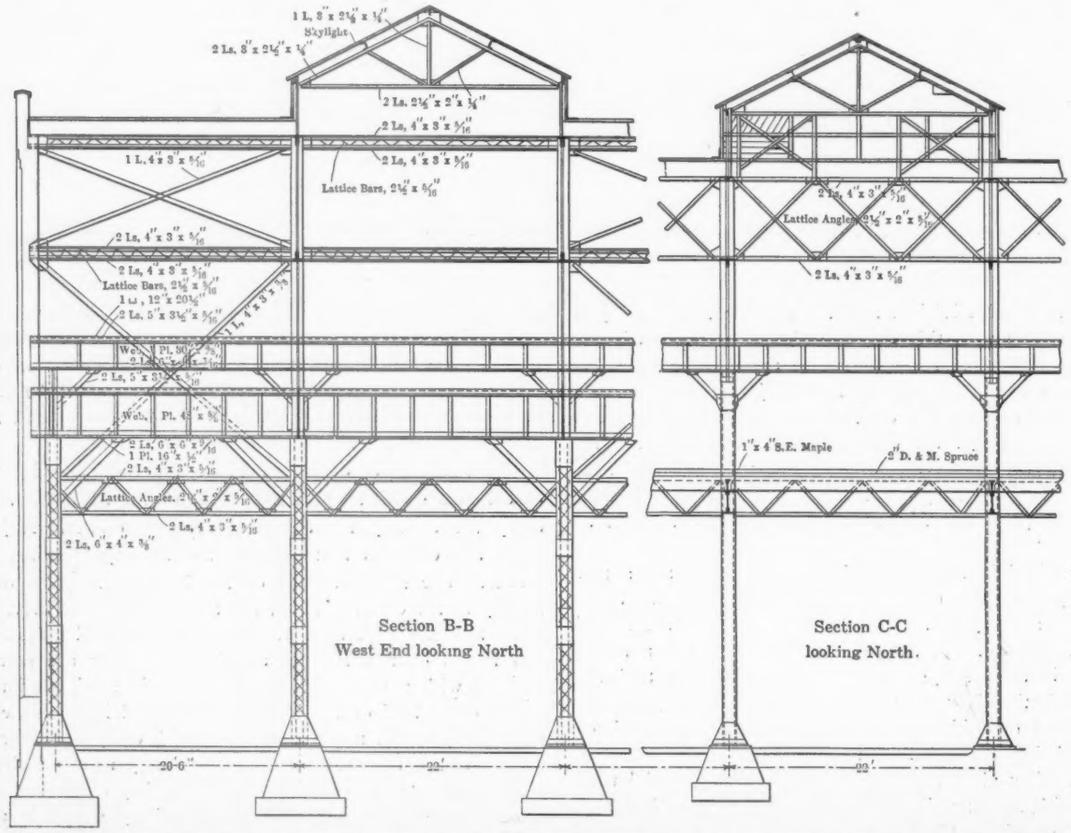
CROSS SECTION OF THE MACHINE, ERECTING AND BOILER SHOP BUILDING. THE SIZE OF THE SKYLIGHTS, DETAILS OF THE ROOF TRUSSES, ARRANGEMENT OF THE GALLERY AND LOCATION OF THE CRANES ARE WELL ILLUSTRATED IN THIS DRAWING.

are grouped the medium weight machines, the arrangement of which is also shown on the insert.

Transverse monitors of a length equal to half the width of the building and 22 ft. wide, covered with heavy ribbed glass, are located 22 ft. apart in the center of alternate transverse bays and furnish light for the inner part of the erecting shop and the heavy machine tool bay.

A 4-inch cement concrete floor laid on cinders is used throughout the whole building. It is formed into square blocks, between each of which there is a strip of tarred paper that will permit the removal and replacement of any blocks that may become broken. Three years' service, however, has shown that this floor is very well suited for its purpose and requires little renewal or repair. It is easily cleaned and allows the trucking of heavy parts if necessary. In front of the various machines and benches, where men stand, removable wooden platforms are laid on top of the cement.

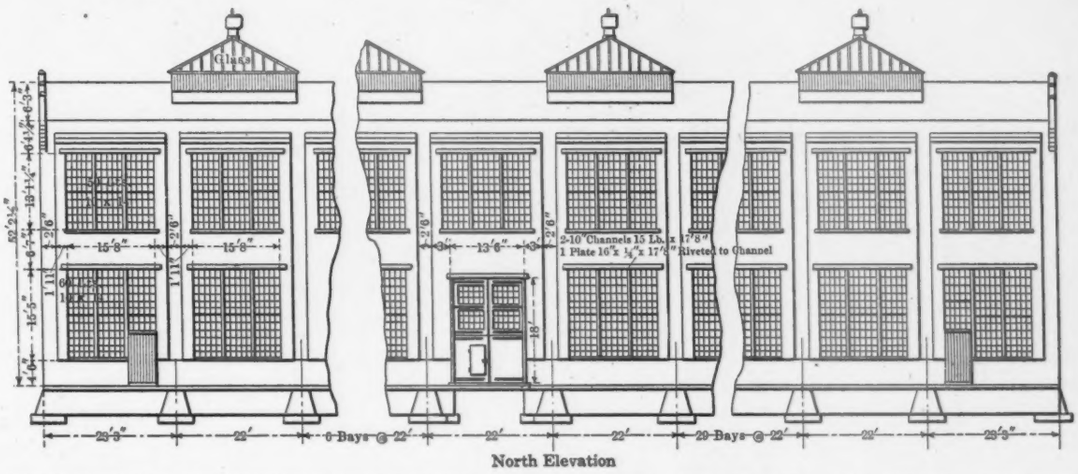
The heating is by the Sturtevant system of hot air carried in concrete ducts under and around the floor next to the outside walls, with numerous discharge openings through risers along all the walls and in the center of the shop. There are four fans, two in fan houses adjacent to the erecting shop and two on



SECTIONAL ELEVATION OF THE STEEL STRUCTURE OF THE LOCOMOTIVE SHOP BUILDING. THIS SHOWS THE CROSS SECTION OF THE SKYLIGHTS LOCATED OVER EVERY SECOND BAY AND GENERAL DETAILS OF THE CONSTRUCTION.

the gallery, so located as to divide the periphery of the building into practically equal parts. The ducts vary in section from 3 ft. x 4 ft. to 3 ft. x 2 ft. 6 in. Manholes to give access to the ducts are provided at ten points and most careful attention has been given to drainage. This system, to the writer's personal knowledge, will provide a comfortable temperature during a blizzard with a very low outside temperature.

General artificial lighting is by Nernst four and six glower lamps over the machine bay and series arc lamps over the erecting floor. Incandescent lamps are used over each machine tool and along the benches. A liberal supply of receptacles along the columns and in the pits are provided for portable lamps and also portable machine tools.



SIDE ELEVATION OF THE LOCOMOTIVE SHOP BUILDING. THE VERY LARGE LIGHTING AREA AND GENERAL ATTRACTIVE APPEARANCE OF THE BUILDING ARE EVIDENT HERE.

BLACKSMITH SHOP.

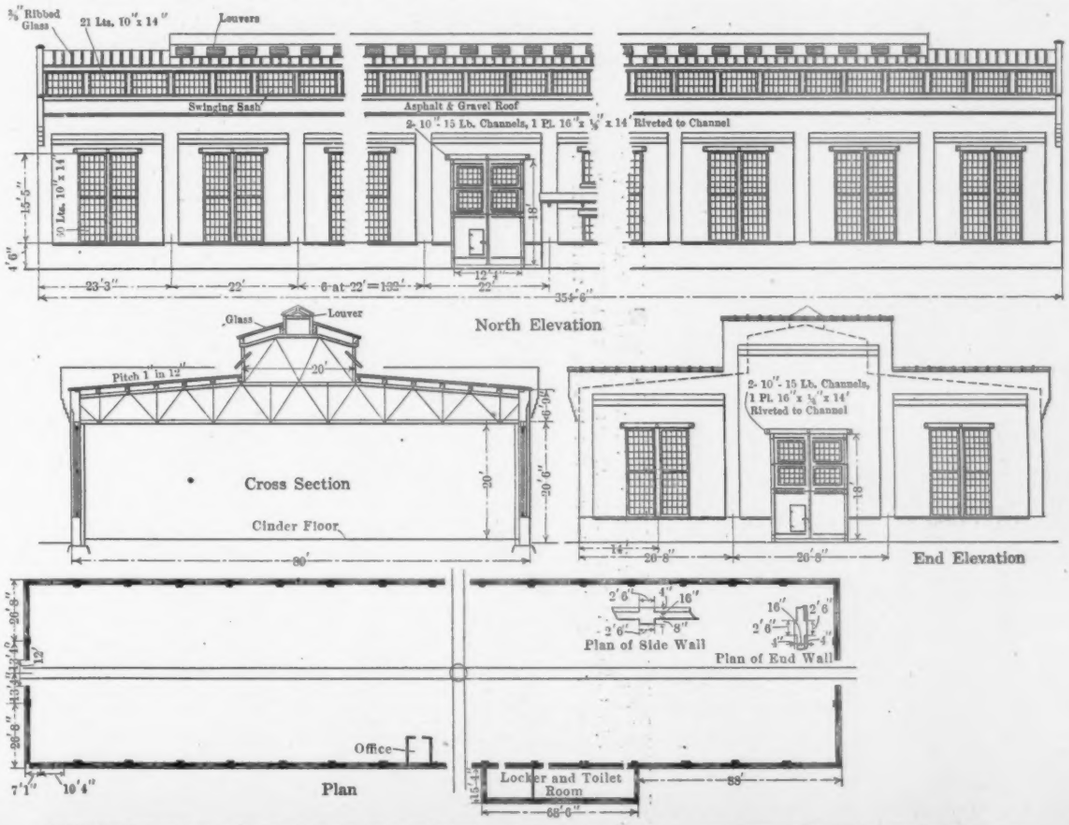
This is a concrete and brick structure with steel roof trusses, having outside dimensions of 80x354 ft. 6 in. A 20 ft. monitor with swinging side lights and a ribbed glass top, which is provided in the center with a continuous lourve, extends nearly the full length of the building. The appearance of the building is similar to the erecting shop, with the exception that the window area provided is not as ample. One of the illustrations give a plan, sectional and elevation view of this building, which illustrates its character very clearly.

The steel work is designed so as to provide ample strength in every direction for jib cranes which may be required to handle heavy weights. Thus at points where cranes are to be located the cross bracing between the roof trusses is carefully studied so as to distribute the stresses over several of them. One of the photographs, showing the interior of the shop, illustrates this construction clearly and shows how the cranes are arranged.

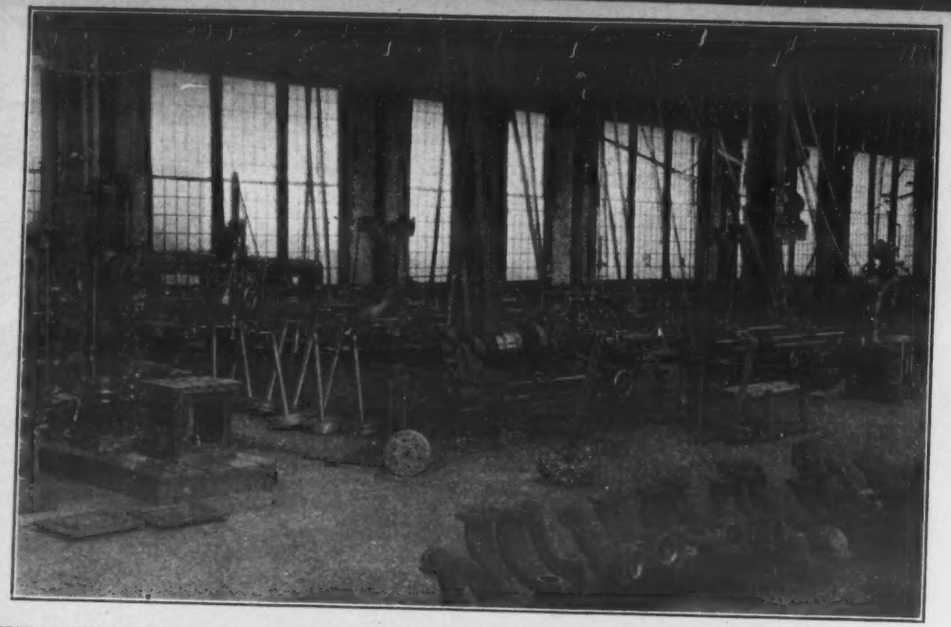
Cinders are used for flooring throughout the whole shop and the artificial lighting is by Nerst glowers, the same as in the machine shop. A Sturtevant fan furnishes air pressure for the forges, the ducts being carried beneath the floor.

IRON SHED.

One of the illustrations gives a general view of the building



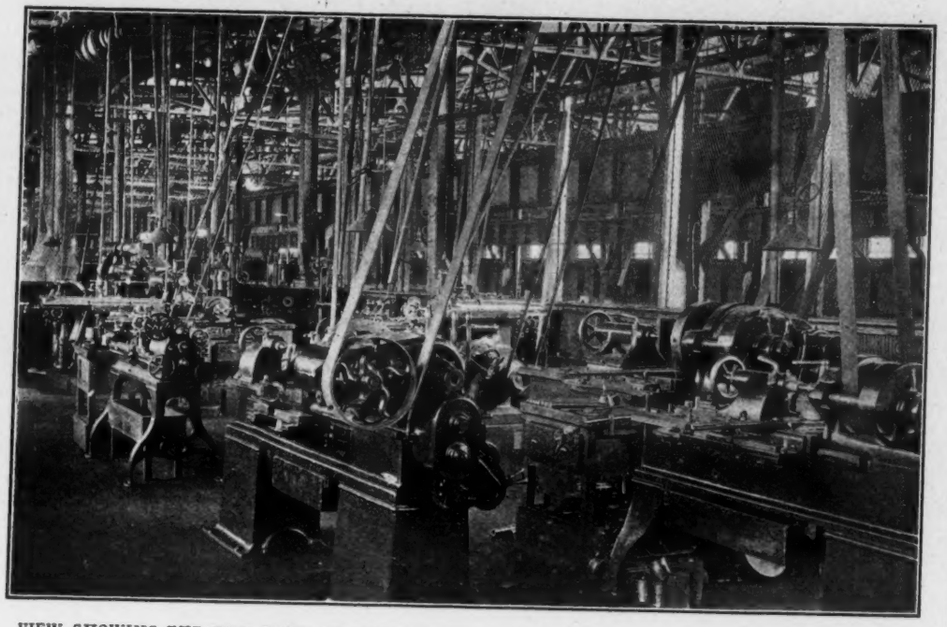
ELEVATIONS, PLAN AND SECTION OF THE BLACKSMITH SHOP BUILDING. THE LONGITUDINAL SKYLIGHT WITH VENTILATORS SIDE AND TOP EXTENDS NEARLY THE FULL LENGTH OF THE BUILDING.



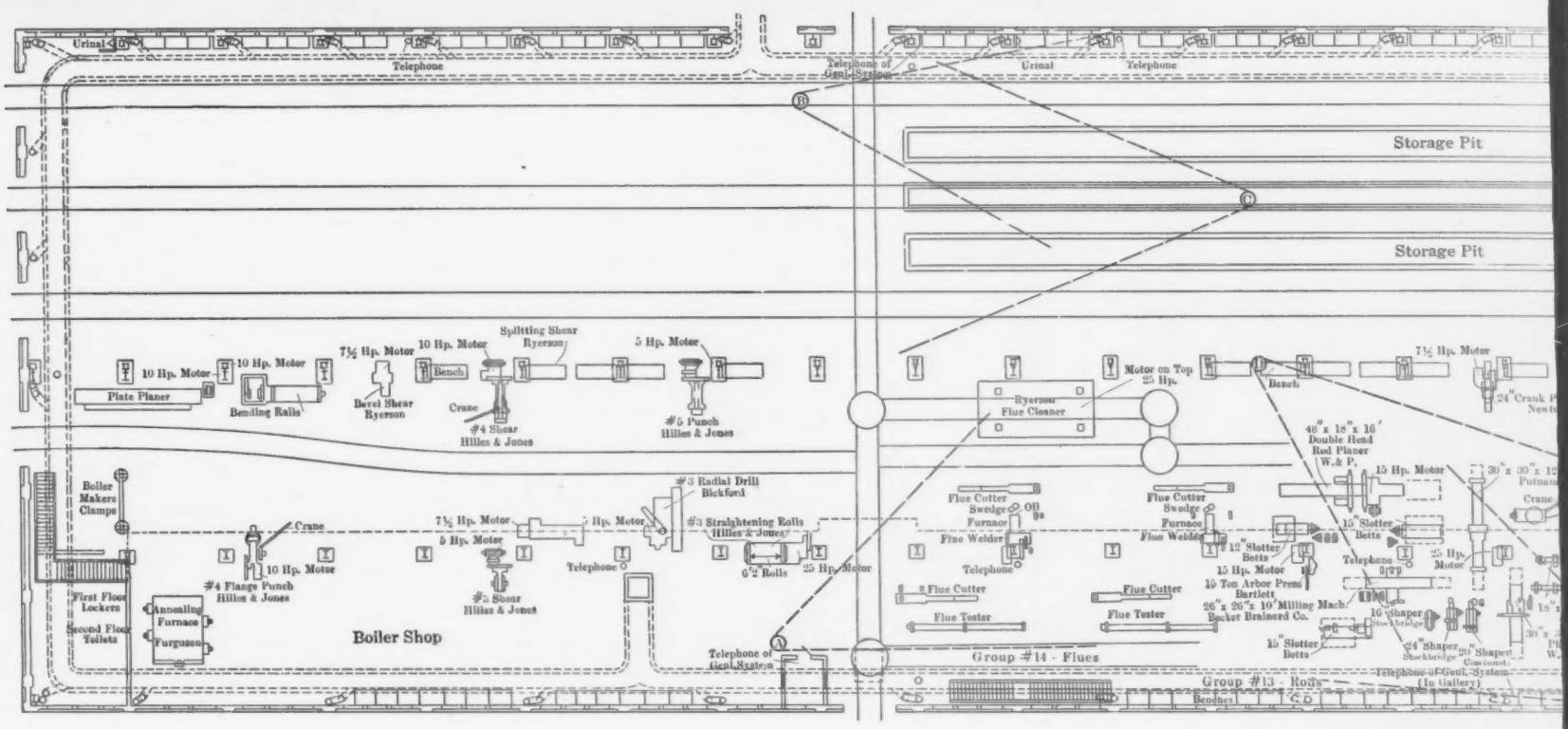
VIEW TAKEN FROM POINT H SHOWING THE PISTON AND PISTON ROD GROUP. THE TOOLS IN THE FOREGROUND ARE SERVED BOTH BY THE 10-TON TRAVELING CRANES AND BY THE AIR HOISTS OR JIB CRANES, TWO OF WHICH APPEAR IN THE ILLUSTRATION. PARTICULARLY GOOD NATURAL LIGHTING IS EVIDENT IN THIS PICTURE.

LOOKING FROM POINT G ON THE BALCONY INTO PART OF THE HEAVY MACHINE SHOP SECTION SHOWING METHOD OF COUNTER-SHAFT SUPPORT; WORK BENCHES BETWEEN THE COLUMNS; AIR CRANES; SOME OF THE LARGE TOOLS AND THE VERY NOTICEABLE ORDERLINESS AND CLEANLINESS OF THE SHOP.

VIEW TAKEN FROM POINT C SHOWING THE TANK REPAIR SECTION. TANKS ARE REPAIRED ON ONE PIT; THE UNDER-FRAMES BETWEEN THE PITS AND THE TRUCK ON THE PIT NEXT TO THE BOILER SHOP.



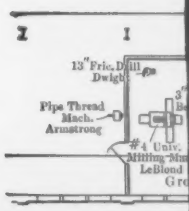
VIEW SHOWING THE TOOL ROOM ON THE BALCONY. THE MACHINES SHOWN ARE ALL DEVOTED TO THE MANUFACTURE OF TOOLS FOR THE SHOP.

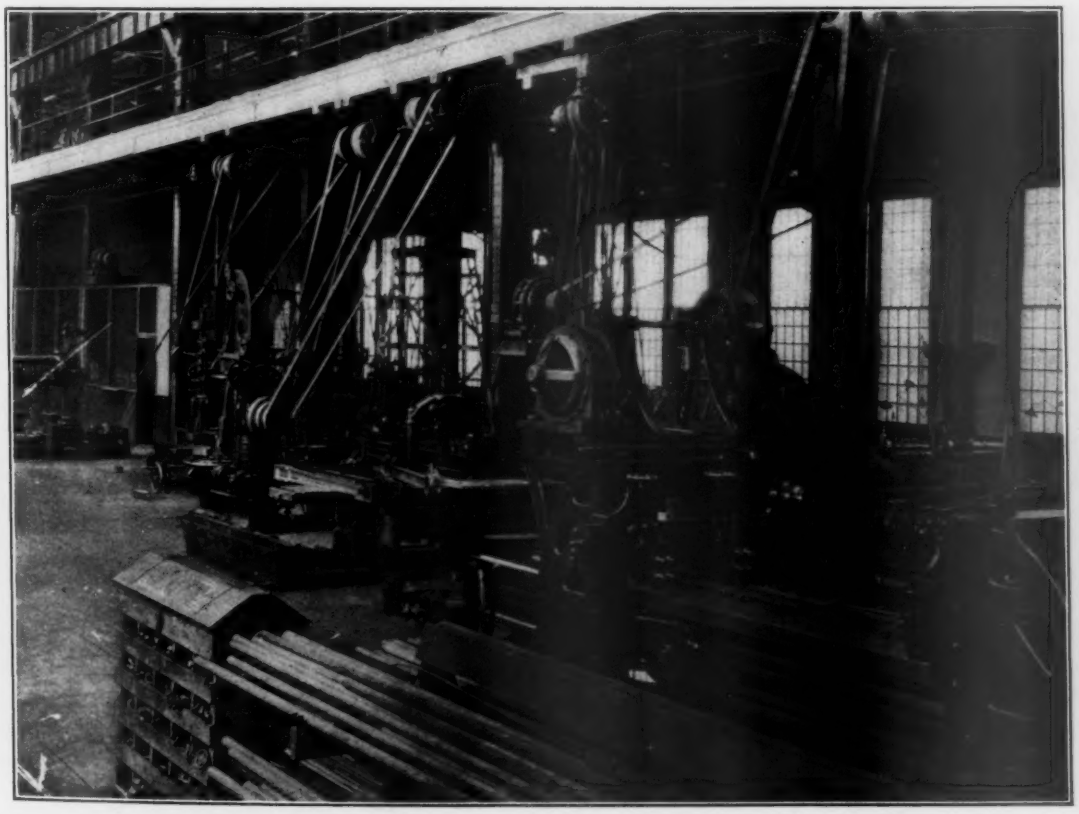


READVILLE LOCOMOTIVE SHOP

OF THE

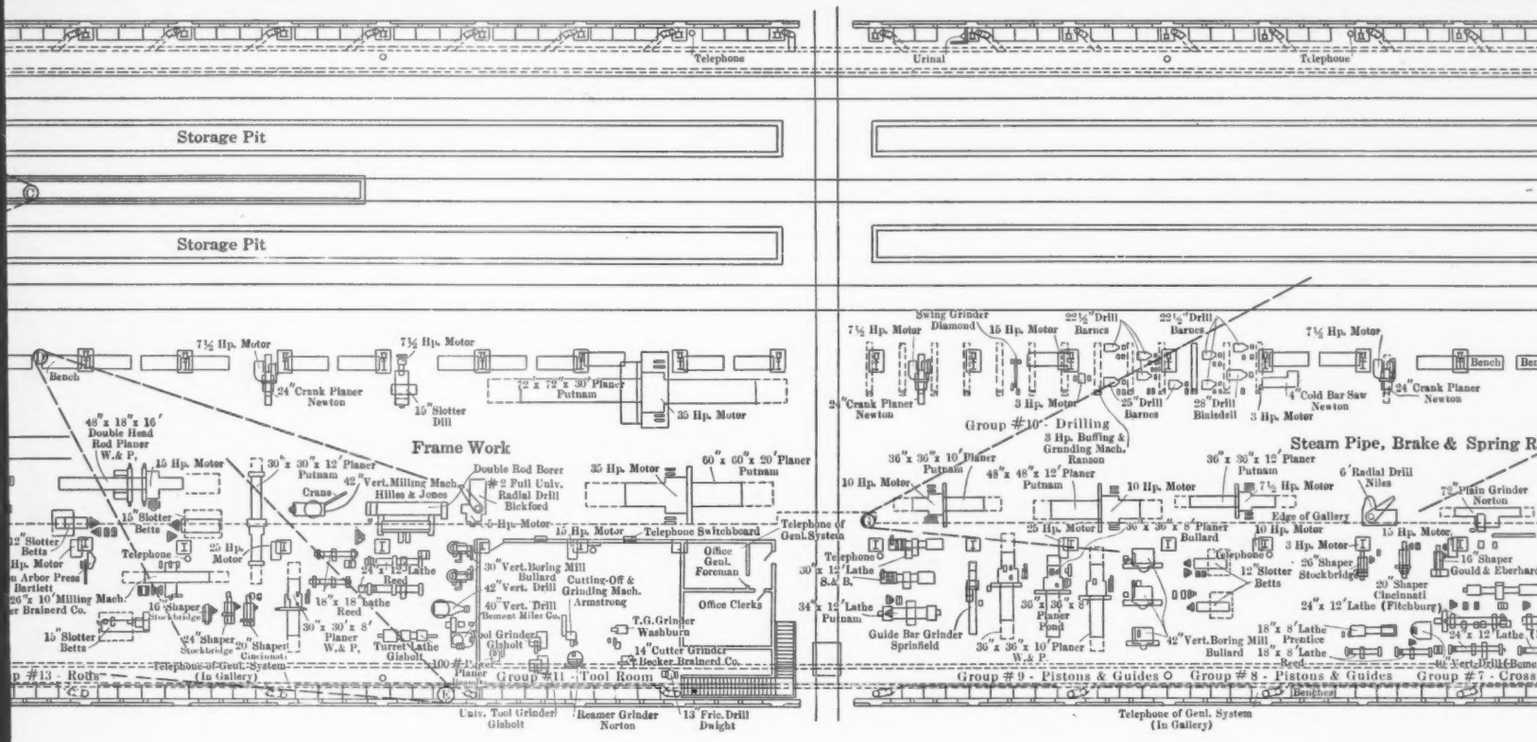
NEW YORK, NEW HAVEN AND HARTFORD RAILROAD



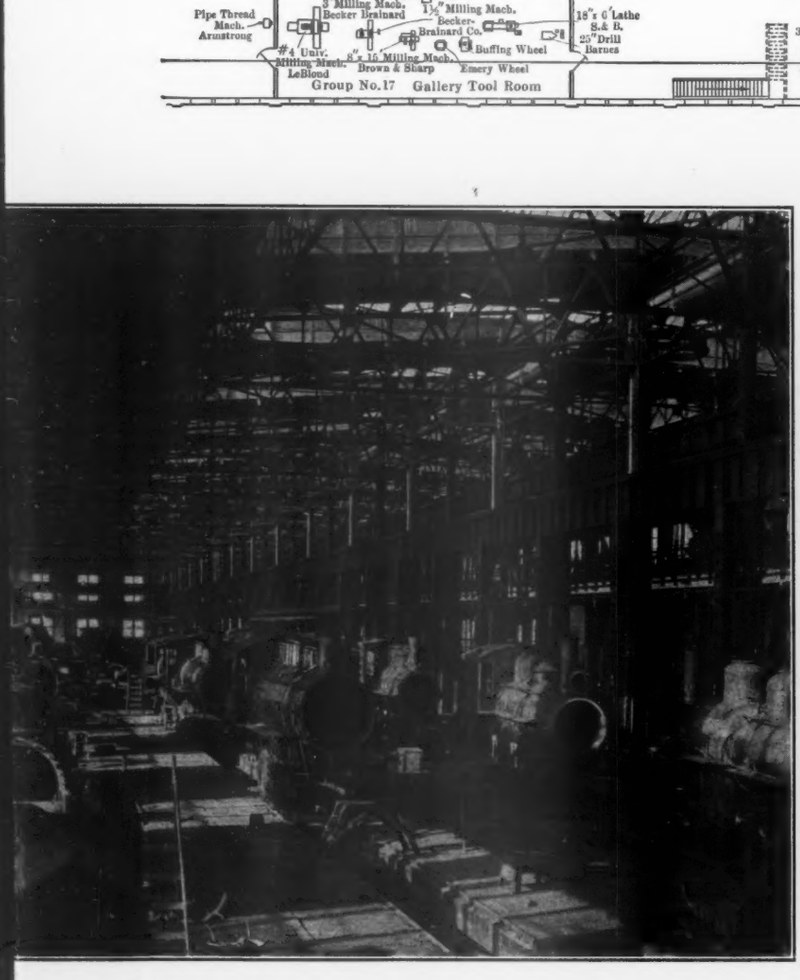


VIEW TAKEN FROM POINT D SHOWING THE ROD GROUP. THE MACHINE IN THE FOREGROUND IS A DOUBLE HEADED PLANER WITH FOUR CUTTER HEADS. THE CONE PULLEY, WHICH APPEARS TO BE PART OF IT, BELONGS TO THE SLOTTER JUST BEHIND IT.

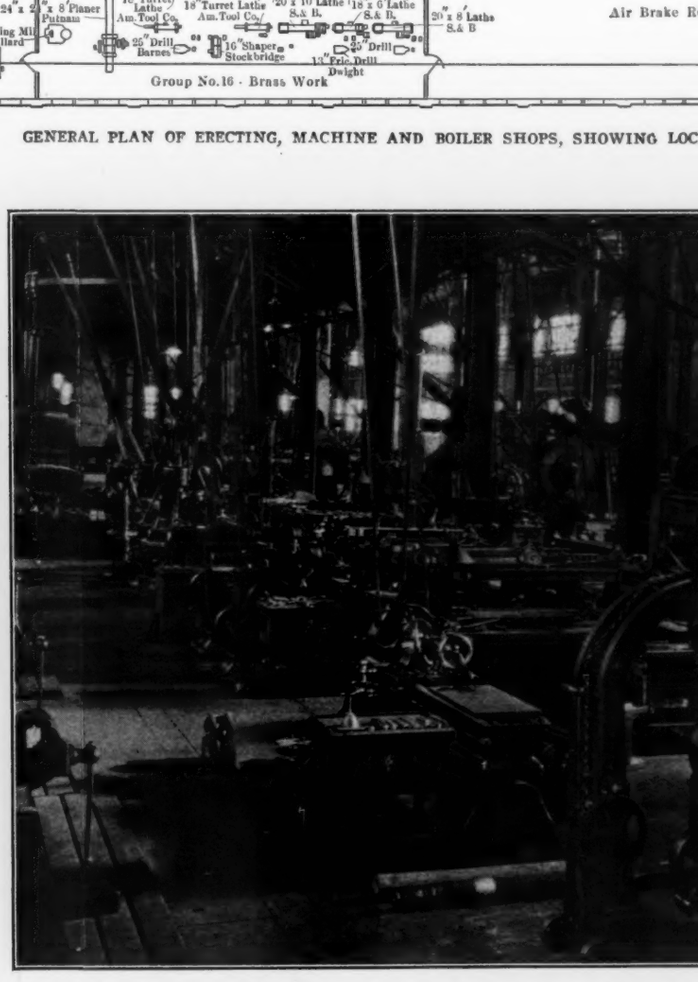
VIEW TAKEN FROM POINT B SHOWING THE GENERAL ERECT
MOTIVES ARE SET STAGGERING, SO AS TO PERMIT THE
GIVES AN EXCELLENT IMPRESSION OF THE



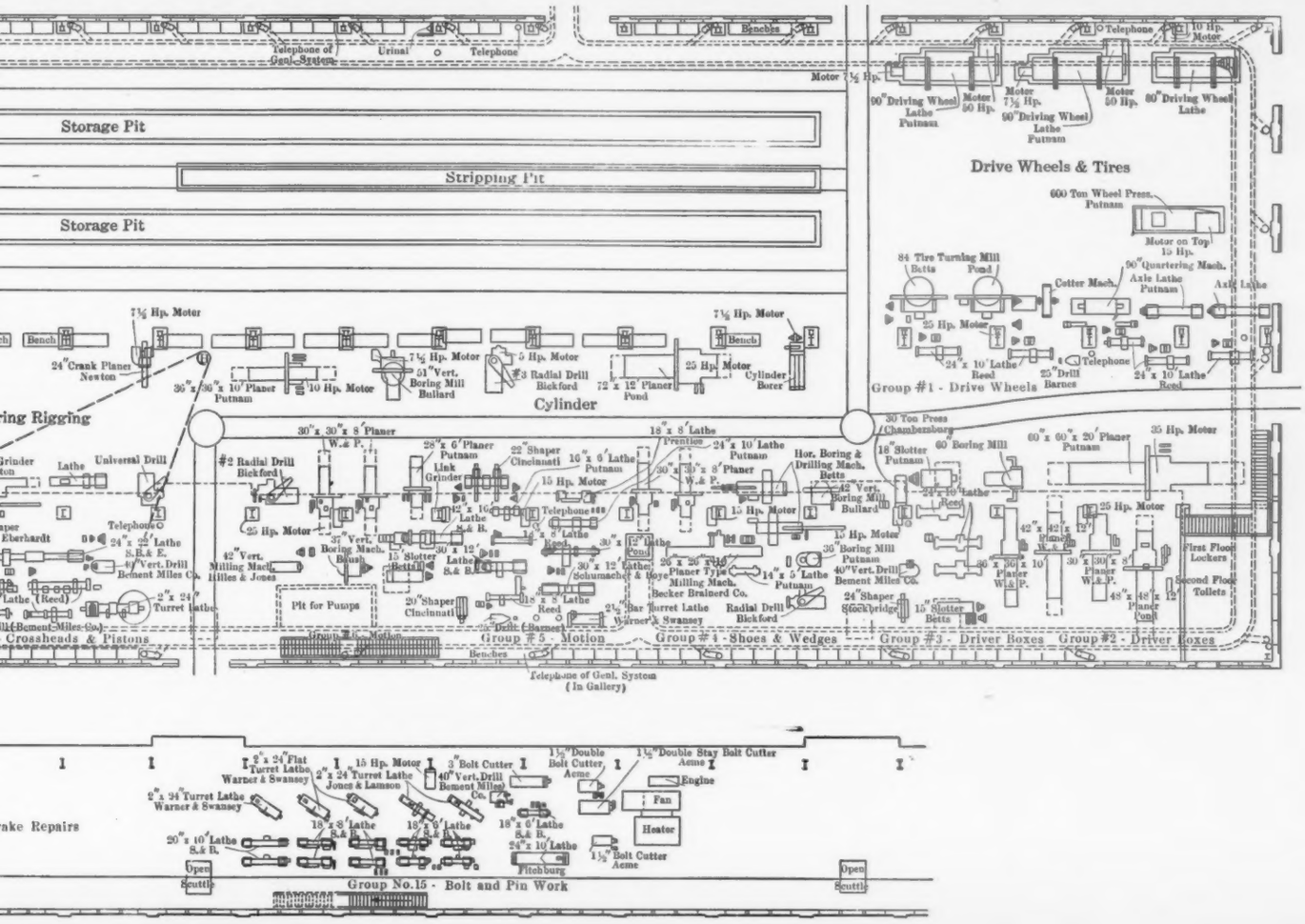
GENERAL PLAN OF ERECTING, MACHINE AND BOILER SHOPS, SHOWING LOC



NT B SHOWING THE GENERAL ERECTING SHOP. IT WILL BE NOTICED THAT THE LOCO-
STAGGERING, SO AS TO PERMIT THE EASY REMOVAL OF THE FLUES. THIS VIEW
N EXCELLENT IMPRESSION OF THE GENERAL APPEARANCE OF THE SHOP.



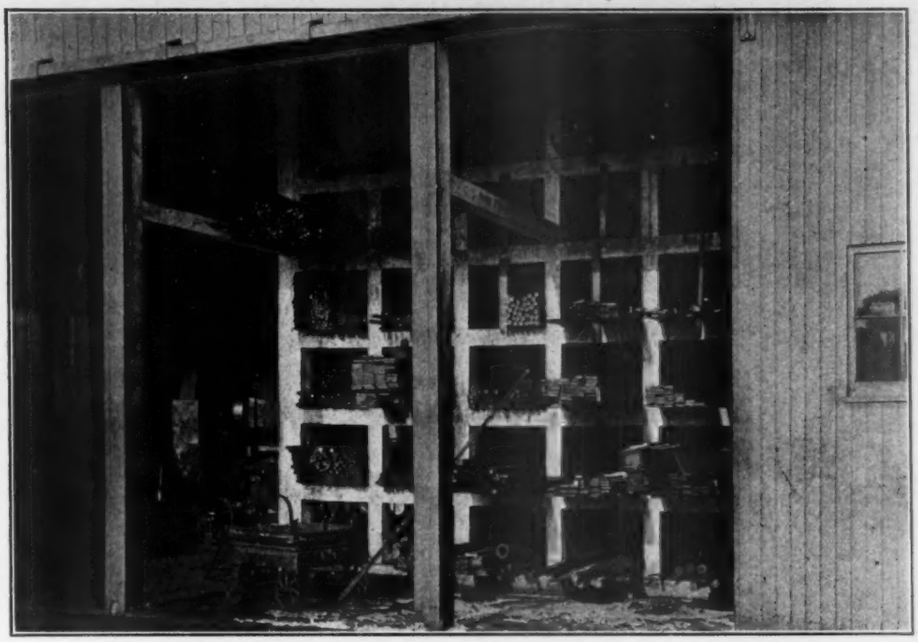
VIEW TAKEN FROM POINT E SHOWING PART OF THE TOOLS DEVOTED TO
BALCONY AND THE TROLLEY AIR HOISTS ARE INDISTINCTLY SHOW
TO THE TOOL ROOM WILL BE NOTICED ON ONE OF THE COLUMNS



LOCATION OF MACHINE TOOLS.

TO ROD WORK. THIS IS UNDER THE
SHOWN. ONE OF THE TELEPHONES
INS IN THE CENTRE DISTANCE.

VIEW TAKEN FROM POINT A SHOWING THE FLUE SHOP. AT THIS POINT ALL FLUES ARE CLEANED, CUT-OFF, SAFE ENDED AND TESTED. IT WILL BE NOTICED THAT THE EQUIPMENT IS IN DUPLICATE WITH THE EXCEPTION OF THE RATTLER.



VIEW SHOWING THE IRON STOCK HOUSE LOCATED JUST OUTSIDE OF THE BLACKSMITH SHOP. THE SHEAR FOR CUTTING OFF THE STOCK IS SHOWN AT THE LEFT AND PORTABLE SCALES IN THE FOREGROUND. A COMPLETE STOCK OF BAR IRON IN COMMERCIAL SIZES IS MAINTAINED IN THIS BUILDING UNDER THE CHARGE OF A STOREHOUSE EMPLOYEE.

located just outside the blacksmith shop, which is used for the storage of bar iron stock. This is a wooden structure fitted with sliding doors in front, the runways of which are so arranged that practically the whole front of the building can be opened up. The racks are of very heavy timber and are marked so that each kind of stock is easily identified. They occupy about two-thirds of the building. Alongside of the racks is an electric driven shear and a portable scale forms part of the equipment. This building is in charge of a storehouse employee, who cuts off, weighs and delivers such material as is ordered on requisition from the foremen. No one is allowed to remove any stock without authority, nor to do his own shearing.

CLEANING HOUSE.

One of the most noticeable features of the whole shop is its remarkable cleanliness. This is due partially to the practice of completely dismantling the locomotive on the stripping pit, which permits the comparatively easy wiping of different parts, but more to the excellent facilities provided for cleaning with the lye vats and the arrangement whereby this is done outside of the shop proper.

A steel framework supporting wooden sides and roof covers two large vats, each provided with large draining platforms. The vats are 18 ft. 6 in. by 10 ft. inside dimensions; the least depth is 7 ft. They are constructed with heavy concrete sides and bottom and are separated by the track which passes through this building into the erecting shop. Alongside each tank is a concrete platform with a decided slope into the tank, covered by a grating of 3 x 6 in. yellow pine strips spaced 2 in. apart upon a framework of 4 x 4 in. spruce joists.

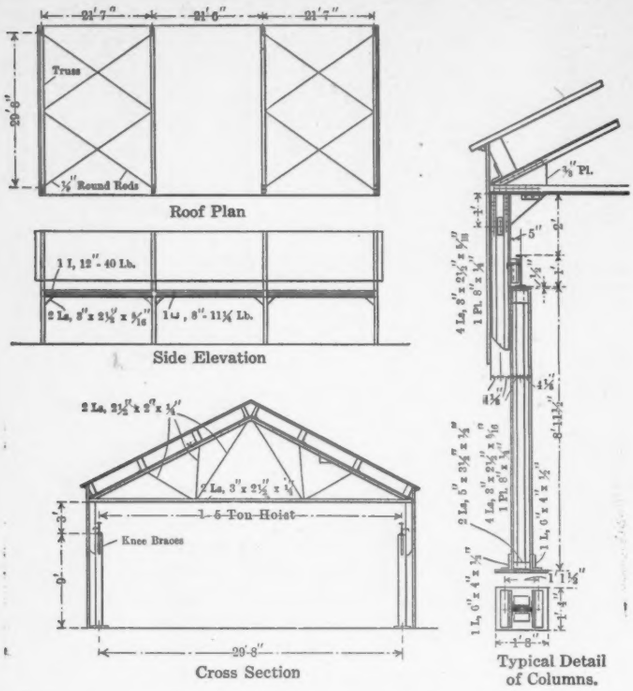
A 5-ton air operated hoist carried upon a traveling girder having a span of nearly 30 ft.., handles the parts from the push cars on the center track, into and out of the vats or the drainage platform. One of the photographs shows an interior view that illustrates the construction of the steel framing and arrangement of this traveling hoist. The floor around the vats and platform is of macadam. The walls of the vats are 18 in. thick and the bottom is 9 in. thick. They were originally waterproofed with a soft soap and alum solution, but it was soon found that the absorption of the oil from the greasy parts put into the vat provided a waterproofing of the very best kind. The top of the vats are covered with large wooden doors handled by the hoist. The room provided in this house is so ample that the usual litter of dirt and greasy parts is nowhere in evidence.

The steel columns supporting the crane runway are built up of angles and plates and carry a 12-inch, 40-pound, I-beam reinforced by an 8-inch channel. These columns are spaced 21 ft. 7 in. apart and to them are riveted on the outside a short strut of similar construction, which carries the simple design of steel roof truss. The enclosing structure is of the simplest character of wooden construction ,with sliding doors on either side where the track passes through the building. Two large ventilators are provided in the roof.

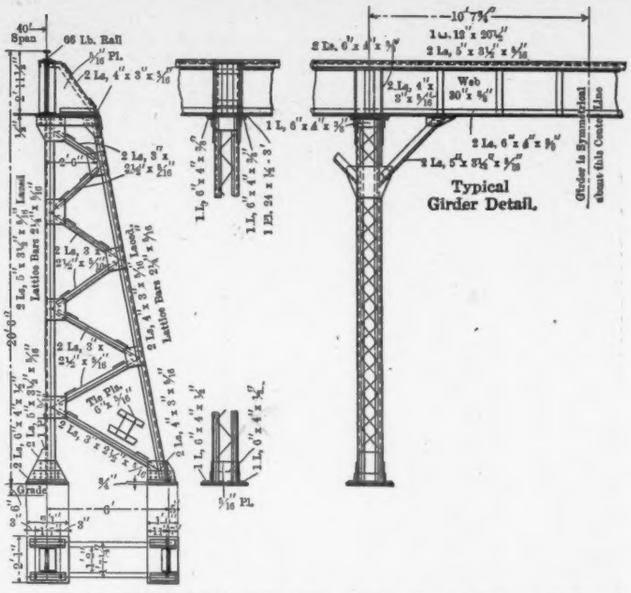
TIRE HOUSE.

All work of removing and replacing tires is done in a separate structure alongside the erecting shop, into which runs a 10-ton crane that covers the storage platform and tracks outside the

VIEW SHOWING THE INTERIOR OF THE CLEANING HOUSE. THE TRAVELING AIR HOIST, LARGE SIZE OF THE TANKS AND DRAINING PLATFORM, AS WELL AS THE STEEL FRAME WORK OF THE BUILDING, ARE WELL ILLUSTRATED BY THIS VIEW. THE HEAVY DOORS COVERING THE VATS ARE HANDLED BY THE HOIST.



GENERAL PLANS AND DETAIL OF COLUMNS OF THE STRUCTURE OVER THE LYE VATS. THIS STEEL FRAME IS ENCLOSED BY A WOOD SHELL. THE METHOD OF SUPPORTING AND BRACING THE CRANE RUNWAYS IS CLEARLY SHOWN IN THIS VIEW.



DETAILS OF THE RUNWAY SUPPORTS OF THE FORTY FOOT CRANE THAT COVERS THE STORAGE YARD AND ALSO ENTERS THE TIRE HOUSE.

building. This structure is of steel frame work enclosed with corrugated iron, the details of construction being shown in one of the illustrations. Swinging doors, operated by means of a wire cable, cover the space provided for the entrance of the crane. The columns supporting the crane runway over the tire platform and storage yard are also shown in detail in one of the illustrations. They are arranged to give a 40-ft. clear span to the crane, the top of the rail being 21 ft. above grade. The runway has a total length of 127 ft. 9 in.

The track passing into this building extends through the erecting shop and into the machine shop, where it is provided with a turntable on one of the longitudinal tracks. A Ferguson oil heater is fitted in the bottom of a sunken heating pit, with a capacity for heating eight tires at one time. On the opposite side of the track are oil heaters, arranged at the floor level, for removing tires. A pair of wheels, if the tires only are to be removed, are set with the axle in the vertical position between the burners, the handling being done by the crane. Transportation to and from the erecting shop is by push cars, the location of the tire house being just outside of the section devoted to the driving wheel work.

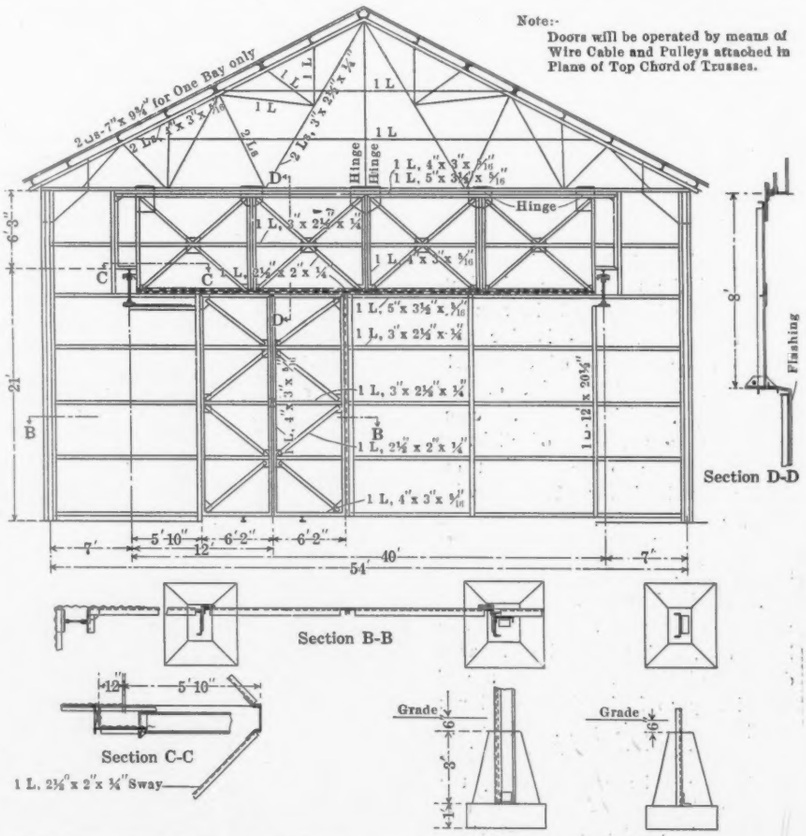
GANTRY CRANE.

For unloading the coal from tenders, loading ashes from blacksmith shop, removing tender trucks or other work of this character, a traveling Gantry crane spanning three tracks is provided in the yard near the blacksmith shop. This crane is fitted with a clam shell bucket for handling coal or similar material and is electrically operated. It has a capacity of five tons. One of the illustrations shows its general appearance.

ERECTING SHOP.

About two-thirds of the floor space beneath the 60-ton crane runway is used for the erecting floor; the remainder is given up to the driving wheel work, which occupies about 100 ft. at one end and the tank and boiler shop work which occupies 188 ft. at the opposite end. The erecting shop is of the longitudinal type, having three tracks. None of these tracks are provided with pits with the exception of about 150 ft. at either end of the center track, which location is used for stripping at one end and for wheeling at the other. Throughout the rest of the shop the floor between the rails is at the same level as that outside.

The stripping pits have concrete walls 15 in. thick, capped by



ELEVATION AND DETAILS OF THE STEEL FRAME OF THE TIRE HOUSE. THIS IS COVERED WITH CORRUGATED IRON SHEATHING. A SWINGING DOOR OPERATED BY WIRE CABLES COVERS THE OPENING OVER THE RUNWAYS WHERE THE TRAVELING CRANE ENTERS. THE BUILDING DOES NOT SUPPORT THE RUNWAYS IN ANY WAY.

yellow pine stringers secured by anchor bolts. These pits drain to two sumps with cast iron gratings, located 50 ft. apart.

Between the longitudinal tracks are storage pits extending the full length of the erecting shop, with the exception of a 20 ft. passageway in the center. These pits are 6 ft. in width, built entirely of concrete, with walls 12 in. thick. They are 2 ft. 10 in. deep at the ends and slope longitudinally each way to traps for drainage. The maximum depth is 5 ft. They are covered by 4x12 in. yellow pine planks, every tenth plank being provided with an extra heavy pair of malleable iron handles set flush with the surface.

VIEW SHOWING THE TIRE HOUSE AND STORAGE YARD. WHEEL CENTRES AND OTHER HEAVY CASTINGS ARE UNLOADED FROM THE CARS TO THE CONCRETE PLATFORMS UNDERNEATH THE CRANE, WHERE THEY ARE STORED UNTIL NEEDED. ALL REMOVING AND APPLYING OF TIRES IS DONE IN THE BUILDING SHOWN AT THE LEFT.

Work benches line the entire outer wall of both the erecting and machine shop and are also conveniently located in the bays between the center line of columns, as is shown in the large general plan. The floor is served by two 10-ton cranes and two 60-ton cranes, each of the latter having 10-ton auxiliary hoists.

LOCATION AND ARRANGEMENT OF THE MACHINE TOOLS.

In the machine shop, which occupies about one-half of the main building, the tools are arranged so that the work on any one part, or of a similar character, is completed in one section of the shop. When a part is delivered to the shop for repairs, or the rough material for a new piece, it is completed and assembled in all its details without leaving the same vicinity. An exception to this is found in the case of tires, which are applied and removed in the building just outside of the main shop.

As is seen from the illustration of the cross section and from several of the photographs, the gallery covers about one-half of the machine shop space and below it are grouped most of the medium weight tool equipment, while the heavier tools are placed beyond the gallery, where they can be served by the 10-ton cranes. These larger tools are, as a general rule, driven direct from motors attached to the machine or located near by. The smaller tools are all group driven, being belted from a line shaft that is carried from the floor of the gallery and is continuous from one end of the shop to the other, being separated into sections as the arrangement of the machines and size of the motor dictates. Each of these sections is also divided into two parts by a flange coupling and there is also flanged coupling on the ends of the shaft at each section, which are in alignment and spaced

VIEW SHOWING THE GANTRY CRANE USED FOR UNLOADING TENDERS, LOADING SCRAP CARS, ETC. THE BUILDING IN THE BACKGROUND IS THE BLACKSMITH SHOP.

one-half inch from a similar coupling on the next section. Thus, in case of a breakdown of a motor in any group it is only necessary to insert a half inch filling piece and the bolts in the coupling to the next group on either side and remove them from the center coupling to permit the motors on the groups adjacent taking up the load of the disabled section. The shafts for each group average about 44 ft. in length. The motors are located on brackets supported by the inner row of columns.

Referring to the illustration on the accompanying insert, which shows the location of the tools in the machine, boiler and erecting shop, it will be seen that four bays at the western end of the shop under the erecting shop cranes are, with the exception of the center track and considerable space on either side for storage, given up to the driving wheel work. Here are located two large 90-inch Putnam lathes of the most modern type, in addition to an 80-inch older lathe, all placed along the southern wall. Opposite these are two 84-inch boring mills for turning tires, one a Betts and the other a Pond; a 90-inch quartering machine and two large axle lathes. The 600 ton Putnam wheel press is placed near the center track, so that the wheels can be delivered and removed by this route. For crank pins and axles there are five 24 inch by 10 ft. Reed lathes grouped just inside of the row of columns and driven by a 25 h. p. motor belted to a line shaft. This forms group No. 1. A 24-inch Barnes drill and a cotter machine, for drilling keyways, etc., are also located in the same group.

Groups two and three, located underneath the gallery directly opposite group one, are given up to driving box work. They include a large 60x60 in. by 20 ft. Putnam planer direct driven by a 35 h. p. motor and four smaller planers belted from the line shaft, driven by a 25 h. p. motor. From the same shaft are also driven three 24 in. x 10 ft. Reed lathes; a 42-inch Bullard boring mill, and also a 60-inch boring mill that was transferred from the Norwood shops. A 5 ft. Bickford radial drill; 40-inch vertical drill; two slotters; 24-inch shaper, as well as two horizontal Betts boring and drilling machines, a 36-inch Putnam boring mill, and a small Putnam lathe, although belted to group four, are used for this work.

Group four is for new shoe and wedge work and includes a large 26x26 in. by 10 ft. Becker-Brainard planer type milling machine and two 30 x 30 in. x 8 ft. Woodward & Powell planers. This group is driven by a 15 h. p. motor.

Repairs to motion work are done in groups five and six, driven by a 15 and 25 h. p. motor, respectively. These two groups include nine lathes of various sizes; a turret lathe, 22-inch double Cincinnati shaper, 20-inch Cincinnati shaper, three planers, No. 2 Bickford drill, 37-inch Baush boring mill, 15-inch slotter, 42-inch vertical milling machine, a link grinder and a small 25-inch drill.

Opposite groups 4, 5 and 6, beneath the craneway and next to the center row of columns, are located a 72-inch by 12- ft. Pond planer driven by a 25 h. p. motor, a No. 3 Bickford drill driven by a 5 h. p. motor, a 51-inch Bullard vertical boring mill driven by a 7½ h. p. motor, a 36 x 36 in. by 10 ft. Putnam planer driven by a 10 h. p. motor and a cylinder boring machine driven by a 7½ h. p. motor, which are used for cylinder work. There is considerable open floor space around these machines and in this vicinity.

In the next three groups 7, 8 and 9, the work on cross heads, pistons and guides is done. In these groups, which are driven by 15 h. p., 10 h. p. and 25 h. p. motors, respectively, are found the following tools:

VIEW SHOWING THE VICINITY OF THE STRIPPING PITS. THE BASKETS ARE FOR CONVEYING THE PARTS TAKEN FROM THE LOCOMOTIVES TO THE LYE VATS AND ARE OF MANY DIFFERENT SIZES AND SHAPES. THE ONE IN THE IMMEDIATE FOREGROUND IS FOR BOILER JACKETS. THE PARTS AFTER CLEANING ARE RETURNED TO THE SHOP IN THE SAME BASKETS.

Three 24 in. by 12 ft. Reed lathes.
2 in. by 24 in. turret lathe.
Two 40 in. Bement Miles vertical drills.
24 in. by 22 ft. Schumacher & Boye lathe.
24 in. by 12 ft. Fitchburg lathe.
Two 18 in. by 8 ft. Reed lathes.
18 in. by 8 ft. Prentice lathe.
72 in. Norton plain grinder.
Two shapers, one Stockbridge (26 in.) and one Cincinnati (20 in.).
16 in. Gould & Eberhardt shaper.
72 in. Niles radial drill, direct driven by 3 h. p. motor.
Two 12 in. Betts slotters.
Three 42 in. Bullard boring mills.
Three 36 by 36 in. by 10 ft. planers, two Woodward & Powell and one Pond.
Springfield guide bar grinder.
Two 30 in. by 12 ft. Schumacher & Boye lathes.
34 in. by 12 ft. Putnam lathe.
36 in. by 36 in. by 10 ft. Putnam planer, driven by a 10 h. p. motor.
48 by 48 in. by 12 ft. Putnam planer, 10 h. p. motor.
36 by 36 in. by 12 ft. Putnam planer, 7½ h. p. motor.

It will be noticed that these tools are grouped so as to leave a wide open space in the center of the groups and between the benches and the tools.

Opposite group 9 is group 10, which is given up to miscellaneous drilling and contains nine drills of sizes from 22½ to 28 in., in addition to a direct driven 4-in. Newton cut-off saw,

a buffing and grinding machine driven by a 3 h. p. motor and a swing grinder. This group is placed between the column next to the erecting shop and its line shaft is carried by brackets supported from the columns, the arrangement of which will be seen at the left hand side of the view taken from point G. The group is driven by a 15 h. p. motor.

Following along under the craneway we next come to two very large planers used for planing frames. One is a 72 x 72 in. by 30 ft. Putnam machine driven by a 35 h. p. motor, and the other is a 60 x 60 in. by 20 ft. Putnam planer, also driven by a 35 h. p. motor. Adjacent to the latter is a 15 in. Dill slotter driven by a 7½ h. p. motor. Opposite the larger planer and under the gallery is the general foreman's office, adjacent to which is the distributing tool room. The number of small tools in this section form group 11, driven by a 15 h. p. motor.

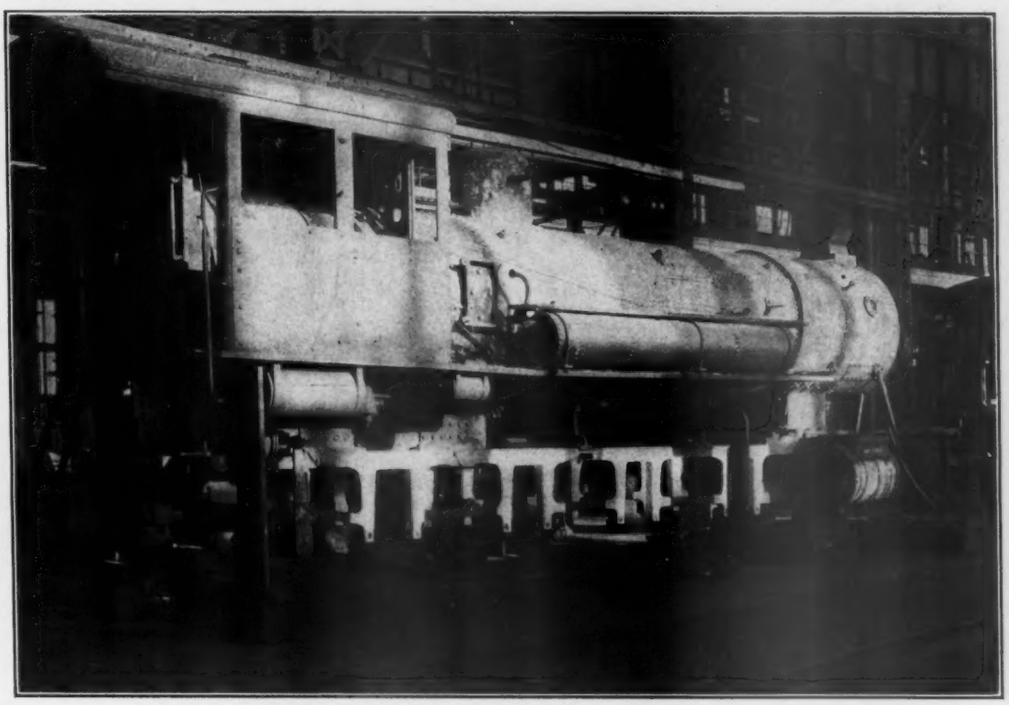
Just beyond the tool room come groups 12 and 13, where the rod work is done. Two of the photographs taken from points D and E show the appearance of this section of the shop very clearly. The tools comprising these groups are as follows:

No. 2 full universal Bickford drill, 5 h. p. motor.
48 by 18 in. by 16 ft. Woodward & Powell double headed rod planer, 15 h. p. motor.
Two 30 in. Bullard boring mills.
42 in. Prentice vertical drill.
40 inch Bement Miles vertical drill.
Gisholt turret lathe.
Double rod borer.
42 inch Hilles & Jones vertical milling machine.
Two 24 in. by 12 ft. Reed lathes.
Two 18 in. by 8 ft. Reed lathes.
30 by 30 in. by 8 ft. Woodward & Powell planer.
20 in. Cincinnati shaper.
24 in. Stockbridge shaper.
16 in. Stockbridge shaper.
Two 15 in. Betts slotters.
26 by 26 in. by 10 ft. Becker Brainard milling machine.
12 inch Betts slotter.
5 ton arbor press.

It will be noticed that there are a number of direct driven 24-inch Newton crank planers located alongside of the columns adjacent to the erecting shop and scattered throughout the length of the building. These planers are used for facing shoes and wedges after they have been fitted to the locomotives and marked for facing. These machines serve the pits in their immediate vicinity and avoid the necessity of transporting these parts from all over the large erecting shop to one point. The same planers when they are not engaged for shoe and wedge work may be used for any miscellaneous emergency work that may be required.

On the gallery is done some light machine work and the repairs, such as cabs and air pumps, that require considerable floor space. It is provided with four extensions, which permit the transfer of material by means of the 10-ton cranes over the heavy machine bay. There is also a runway of single I-beams supported from the roof trusses and located near the outer wall, on which there are two 1½ ton electric hoists. A number of openings or hatchways through the gallery floor permit these hoists to handle material from the floor below to any part of the gallery, or vice versa. There is a similar runway with three hoists underneath the gallery just in front of the benches.

Beginning at the west end of the gallery, there is first a large wash room, then a section with benches and clear space for light electric and machine repairs; following this comes machines for bolt and pin work, arranged as group 15 and driven by a 15 h. p. motor. This group contains the following tools:



LOCOMOTIVE AS IT COMES FROM THE STRIPPING PIT. IT WILL BE NOTICED THAT IT IS THOROUGHLY STRIPPED AND THOROUGHLY CLEANED. THE PEDESTALS ARE PAINTED A GLISTENING WHITE BEFORE THE LOCOMOTIVE IS LIFTED BY THE CRANE AND THIS OPERATION, TOGETHER WITH A FEW BLOWS OF A HEAVY SLEDGE WILL MAKE ALL CRACKS CLEARLY EVIDENT.

24 in. by 10 ft. Fitchburg lathe.
Two 20 in. by 10 ft. Schumacher lathes.
Four 18 in. by 8 ft. Prentice lathes.
Five 18 in. by 6 ft. Schumacher lathes.
Three 2 in. by 24 in. Warner & Swasey flat turret lathes.
Two 2 in. by 24 in. Jones & Lamson flat turret lathes.
40 in. Bement vertical drill.
3 in. bolt cutter.
1½ in. Acme bolt cutter.
1½ in. Acme double bolt cutter.
1½ in. Acme double staybolt cutter.

Beyond this group are benches, racks and other equipment for repairing air pumps, triple valves, etc. Then comes a space enclosed by heavy wire netting where all of the brass work is done. These machines form group 16, driven by a 15 h. p. motor, and include the following tools:

Two 20 in. by 10 ft. Schumacher & Boye lathes.
20 in. by 8 ft. Schumacher & Boye lathe.
Three 18 in. by 6 ft. Schumacher & Boye lathes.
Four 18 in. Fox lathes (American Tool Works Co.).
18 in. Fox turret lathe (American Tool Works Co.).
24 in. by 8 ft. Putnam planer.
40 in. Bement vertical drill.
Three 25 in. Barnes vertical drills.
13 in. Dwight friction drill.
37 in. Bullard boring milll.
16 in. Stockbridge shaper.

The next group is 17, driven by a 15 h. p. motor, and includes the machines for manufacturing tools. This space is also enclosed by heavy wire netting. Beyond this is the pipe shop, followed by the tin shop, which in turn is followed by the carpenter and paint shop, where cab work, making running boards, etc., is done. At the east end of the gallery is another wash room.

BOILER SHOP.

The east end of the section of the building otherwise devoted to the machine shop is used by the boiler shop, the flue work occupying the space just next to the rod gang, the machines being arranged to form group 14. In this group are two complete outfits for cutting-off, safe ending, swaging and testing flues. Alongside of them, beneath the craneway, is a depressed Ryerson flue cleaner, driven by a 25 h. p. motor. Group 14 has a 10 h. p. motor.

Between the flue and boiler shop is a transverse track which continues through the building and to the outside on either side, being provided with turntables connecting to the longitudinal tracks, one of which passes over the flue cleaner and the other alongside of the flue tester.

In the boiler shop are the following machines:

No. 3 Hilles & Jones straightening roll.
No. 5 Hilles & Jones punch driven by a 5 h. p. motor.
No. 4 Hilles & Jones shear driven by a 10 h. p. motor.
Ryerson bevel shear driven by a 7½ h. p. motor.
No. 3 Bickford radial drill driven by a 5 h. p. motor.
Ryerson splitting shears driven by a 7½ h. p. motor.
No. 3 Hilles & Jones shear driven by a 5 h. p. motor.
Set of bending rolls driven by a 10 h. p. motor.
Plate planer, 10 h. p. motor.
Hilles & Jones flange punch, 10 h. p. motor.
Ferguson annealing furnace.
Set of boilermakers clamps.

TANK SHOP.

Tanks, underframes and trucks are repaired at the east end of the erecting shop. It is necessary to keep the center track at this point clear in order to permit the exit of finished locomotives, therefore tenders are brought in on one of the side tracks; the underframe is lifted from the trucks by the crane and set upon low horses between the tracks. The tank is then removed from the underframe and set upon high horses that permit working on the bottom sheets. These are usually over one of the side tracks. This arrangement is shown in the photograph from point C and permits the convenient repair of all three parts of the tender simultaneously. It is the custom of the shop to remove and repair the tanks of every tender coming in and a leaky tank going out of the shop is unknown.

BLACKSMITH SHOP.

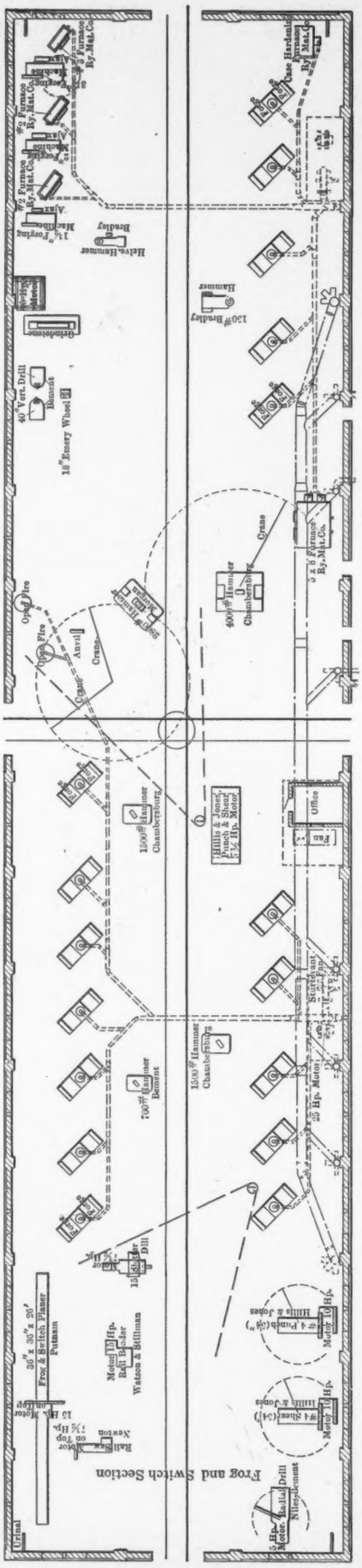
The blacksmith shop proper contains seventeen double forges, a 700 pound steam hammer, two 1,500 pound steam hammers, a 2,800 pound steam hammer and a 4,000 pound steam hammer, in addition to a large punch and shear, open fires and a large oil furnace. There is also at the opposite end of the shop, near the five double forges there located, a Bradley hammer and a Helve hammer.

The forge shop contains three Ajax forging machines, one 1½ inch, one 2 inch, and one 3½ inch, with Ferguson furnace adjacent. These machines, in addition to the grindstone, emery wheel and two 40-inch vertical drills, are driven from the line shaft connected to a 75 h. p. motor; the Helve hammer also connects to the same shaft. It will be noticed that a liberal amount of floor space has been left in front of the forging machines in this section of the shop for storage of raw material and finished forgings.

FROG AND SWITCH SHOP.

The east end of the blacksmith shop building is given up to tools and floor space for making and repairing frogs and switches. The tools are all direct driven and consist of a large 36 x 36 in. by 20 ft. Putnam frog and switch planer driven by a 15 h. p. motor, Newton rail saw, 7½ h. p. motor, Watson & Stillman rail bender, 15 h. p. motor, 15 in. Dill slotter, 7½ h. p. motor, 5 ft. 6 in. Niles radial drill, 5 h. p. motor, and two No. 4 Hilles & Jones shears, each driven by a 10 h. p. motor.

Each of these machines is served by jib cranes, which are arranged to overlap and permit the easy handling of all material from the track cars to and from the different machines. A gen-



PLAN OF BLACKSMITH SHOP SHOWING THE LOCATION OF TOOLS, FORGES AND OTHER EQUIPMENT.

VIEW TAKEN FROM POINT I SHOWING A SECTION OF THE BLACKSMITH'S SHOP. THE CRANE COVERING A FULL CIRCLE, IS SUPPORTED ENTIRELY FROM THE ROOF AND SERVES A LARGE HAMMER, LARGE FORGE AND FACE PLATE AND TWO TRACKS. THE EXCELLENT OVERHEAD LIGHTING IS EVIDENT IN THIS PICTURE.

eral view of part of this shop is shown in the photograph taken from point J.

TELEPHONE SYSTEM.

There is a general telephone system connecting all of the different offices throughout both the locomotive and car shops, which also has a connection to the regular Bell system. These 'phones are located at convenient points throughout all of the buildings, so that connection can be had with the shop superintendent, general foreman, or between the different foremen.

In addition to this there is installed a local telephone system connecting the machine, erecting, boiler and tank shops with the tool room. This system is for the tool supply service only and the location of the numerous connections throughout these shops is shown on the general tool layout and in some of the photographs. The 'phones are attached to the building columns and each has a separate line to the switchboard located in the tool room, where an attendant is stationed. The workmen are not allowed to go to the tool room to obtain tools they require, but step to the nearest 'phone and order what they wish, their orders being written down by the attendant at the switchboard. The tools are then collected by the tool room force, given to a boy, who delivers them to the man at the machine. Push carts are provided where the tools are large or a large number are required. The boy who delivers the tools takes either the check or exchanged tool back with him.

This scheme obviates the delay of waiting in line at the tool room window, which in some shops is quite serious. There is also a double check on every tool taken out of the tool room, since the order sent in by the man at the 'phone is put down in writing, delivered to the man who fills the order, and later filed for reference.

OPERATION.

Locomotives are ordered to the shop by the Mechanical Superintendent, who acts upon the reports of the various master mechanics as to the condition of the locomotive. In cases of unusual repairs, such as new frames, new cylinders, new firebox, etc., the shop is notified beforehand as to what will be required. The locomotives when ordered to the shop are accompanied by a report from the master mechanic, which shows their exact condition, and with this report at hand the work of getting out new parts that need renewing is started at once. When the locomotive arrives upon the shop tracks it is immediately inspected by the shop inspectors, who present a written report. If this shows the renewal of any part that was not shown on the first report orders are immediately issued to suit. Thus the major part of the work is well under way before the locomotive is actually brought into the shop, it being held on an outside track until ordered in and it is not ordered in until the shop is ready to actually start work upon it.

Upon arrival at the stripping pit at the west end of the erecting shop the stripping gang, consisting of a foreman and leader and 25 men, starts to work and quickly prepare it for removal from the wheels. It is then lifted off and set down upon blocks upon the stripping pit, where the strippers continue their work. Since all the locomotives coming to this shop are in for heavy repairs they are very thoroughly stripped at this point. Cylinder heads are taken off, pistons removed, valves and valve chests removed,

VIEW TAKEN FROM POINT J SHOWING PART OF THE FROG AND SWITCH SECTION OF THE BLACKSMITH SHOP. AN EQUAL SPACE ON THE OTHER SIDE OF THE TRACK IS ALSO DEVOTED TO THIS WORK. THE STANDARD TYPE OF JIB CRANE USED THROUGHOUT THE BLACKSMITH SHOP IS WELL ILLUSTRATED IN THIS PICTURE.

guides taken down, all spring rigging removed, in most cases jacket and lagging are taken off, steam and dry pipes, netting, etc., are taken out, and, in fact, practically every part that will require repairs or that would hinder the repairs of other parts, is taken off by the stripping gang.

Receptacles of various sizes and kinds, made of heavy netting, strap iron, or perforated plate, are provided for the use of the stripping gang, who place all removed parts in them for transferring to the lye vat. One of the photographs snows a view in this vicinity and illustrates a number of these baskets. The wheels and axles are wiped clean, as is also the whole stripped locomotive. After it is thoroughly cleaned the frames at the pedestals are painted a glistening white. The parts in the baskets are carried by the crane to push cars on the transverse tracks in the center of the shop, which transport them to the lye vats, where they are soaked, drained, dried and brought back into the erecting shop in their original baskets. The different parts were marked with the number of the engine upon their removal and when they are returned in a clean condition they are distributed to the proper gangs by the laborers. The foremen of the various machine gangs keep an eye upon the parts when they are removed, inspect them, and watch out for their return from the cleaning house.

The stripped locomotive is picked up by the large cranes and set down upon blocks on the side tracks in such a position that the flues can be easily removed without being interfered with by the locomotive in front. This is done by setting the locomotive at a slight angle with the track. The blocks are located underneath the cylinders and at the rear end of the frame and several blows are given to the frame at each of the pedestals with a heavy sledge, which in connection with the lifting of the locomotive by the crane invariably makes any small cracks show clearly against the white paint.

Having arrived upon the blocks the locomotive, if the frames or cylinders are not to be removed, is all ready to immediately start building up again.

The shop organization is such that the general foreman is in complete charge of the locomotive repairs and has under him an erecting shop, machine shop, boiler shop, tank shop and blacksmith shop foreman. Each of the groups of tools throughout the machine shop, which work on one particular kind of work, is presided over by a leader, who reports to the machine shop foreman. The erecting shop foreman also has assistants, who have special duties. All of these foremen and leaders meet once a week and discuss the condition of affairs as they stand at that time and report upon future work. In this meeting the schedule for the engines to go out during the following week is carefully discussed and formulated. Each man is furnished with a copy of this and understands the exact date at which the work from his gang must be delivered to the erecting floor. If for some unexpected reason he is unable to maintain his schedule he reports immediately and the locomotive is redated to suit, another engine being pushed up into its place, and all men concerned notified accordingly.

This shop was built to give heavy repairs to 45 locomotives per month. At the present time it is turning out on an average of 41 locomotives per month, and it is clearly evident that its capacity is nowhere near reached.

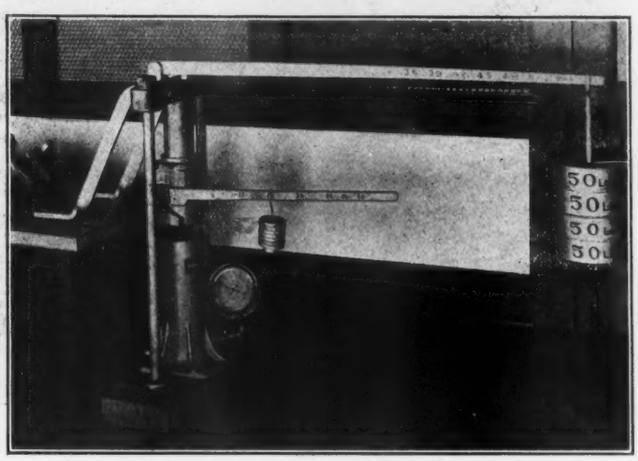
The regularity with which the locomotives leave the shop is an evidence of good mangement and hearty co-operation. A record for a recent month showed that on no working day were there no locomotives turned out of the shop and on no working day were there more than two turned out, the ones and twos alternating almost evenly. It was also very noticeable that when a locomotive leaves the shop building it is finished. On a three days visit at no time was the writer able to find any workman, outside of the breaking-in man and his fireman, engaged upon a locomotive that had left the shop.

WAGES INCREASED.—The Pennsylvania System has voluntarily made an increase of 6 per cent. in the wages of all employees now receiving less than $300 per month.

APPRENTICESHIP.

EXPLAINING THE PRINCIPLES OF LEVERAGE.

A unique method for explaining the principles of leverage has been devised at the Beech Grove shops on the Big Four Railroad of the New York Central Lines. The illustration shows a hydraulic jack arranged so that a small weight hung on the handle will lift a large weight on a beam connected to the jack head. This not only instructs the boys in the mechanical prin-



APPARATUS USED IN CONNECTION WITH LEVERAGE PROBLEMS.

ciples of leverage, but it familiarizes them with the construction and working of the jack itself. Below are some problems which are used with this work:

JACK PROBLEMS.

1. (A) With weights in position shown on blue-print, what would be the weight on jack head due to the 50-lb. weights on weight lever? (B) What would be the pressure per square inch on the ram? (C) What pressure per square inch on piston?

2. What would be the pressure on the knuckle due to the above pressure on the ram?

3. Place weights in position shown and see if they balance.

4. (A) What is the pressure per square inch on piston due to the weight shown on jack lever? (Make no allowance for friction.) (B) What weight could be lifted by jack ram due to the above weight shown on jack lever? (C) Does the weight figure out to be more or less than the weight actually lifted?

5. When the weights are in the position shown what is the ratio of the pressure on jack head to the total pressure on bottom of jack ram? This result is called the jack efficiency. In this case what is the per cent.?

6. What is the ratio of ram area to piston area?

7. What is the leverage ratio of jack lever (at the 24" mark) to the lever arm?

8. If 10 lbs. were placed at the 24" mark on jack lever, what weight could be raised by the jack ram, figuring the jack efficiency at 90%?

9. At what distance out on weight arm would it be necessary to place 150 lbs. in order to balance the 10 lbs. on the jack lever? (Prove your answer by placing the 150-lb. weight the required distance found.)

10. If 200 lbs. were placed at the 28" mark on jack lever what pressure per square inch should the gauge show, figuring the efficiency at 90%.

11. If a man weighing 150 lbs. were to apply his full weight at the 24" mark on jack lever, how many tons could he raise on jack head?

APPLYING AIR BRAKES WITHOUT SHUTTING OFF.—It is noticeable on high speed runs that some engineers, when wishing to reduce the speed from, say, 55 to 35 miles an hour, will apply the air without shutting off. Not only does this produce more wear and tear on the brake shoes, tires and brake rigging, but it is a waste of steam and consequently coal. More time is also required to slow down.—*From a fuel engineer's notebook.*

TEST OF LUBRICATING OILS.—In a paper read before the American Society for Testing Materials, Robert Job describes a simple test of the value of lubricating oils under service conditions. He found that when heated to a temperature of 450 degrees Fahrenheit the oils which had given bad results showed a very marked darkening of color, while those which had proved satisfactory showed very little change.

BELT FACTORS.†

WILLIAM W. BIRD.*

The question of the proper size of a leather belt for a given power transmission resolves itself into a question of selecting various factors. These factors have been worked out by experiments, by analytical methods, and in practice. Those who are interested in the development of this work are referred to books and papers on this subject and especially to the Transactions of the American Society of Mechanical Engineers. This article will simply deal with the facts established and endeavor to put them into convenient form for use in actual practice.

The horse-power that a belt will transmit depends upon the effective tension and the belt speed. The effective tension depends upon the difference in the tensions of the two sides of the belt and on the surface friction, which depends upon the ratio of the tensions and the angle of wrap.

Experiments and practice have shown that a belt of single thickness will stand a stress of 60 lbs. per inch of width and give good results, that is it will only require an occasional taking up and will have a fairly long life. The corresponding values for double and triple belts are 105 and 150 lbs. per inch of width provided the pulleys are not too small.

Experiments have shown that on small pulleys the ratio of the tensions should not exceed 2, on medium pulleys 2.5, and on large pulleys 3. The larger the pulley, the better the contact is; the thinner the belt, the better the contact is for the same size of pulley. When the pulley diameter in feet is three times the thickness of the belt in inches, or in this proportion, we get equivalent results for different thicknesses of belts. This gives us a method of classifying our pulleys. The belt has to adjust itself in passing over a pulley due to its own thickness. Some adjustment is also necessary on account of the crowning of the pulley. These adjustments account for the different ratios for the various pulley diameters. The effects of the crown and pulley diameters are not usually considered in belt rules, which is a grave mistake. The ratios are for 180 deg. wrap and decrease with less contact.

The creep of the belt depends upon its elasticity and the load, and experiments have shown that this should not exceed 1 per cent. in good practice. In order to keep this creep below 1 per cent., it is necessary to limit the difference of tension per inch of width of single belt to 40 lbs. The corresponding values for double and triple belts are 70 and 100 lbs. per inch of width. These figures are based on an average value of 20,000 for the running modulus of elasticity of leather belting.

TABLE I.

Diameter of Pulley	Under 8"	8"–36"	Over 3 feet	Under 14"	14"–60"	Over 5 feet	Under 21"	21"–84"	Over 7 feet
Thickness of Belt	Single	Single	Single	Double	Double	Double	Triple	Triple	Triple
Factor	1100	920	830	630	520	470	440	370	330
Difference of Tensions	30	36	40	52.5	63	70	75	90	100
Per Cent. of Creep	.74	.89	.99	.74	.89	.99	.74	.89	.99
Ratio of Tensions	2.00	2.50	3.00	2.00	2.50	3.00	2.00	2.50	3.00
Tension on Tight Side	60	60	60	105	105	105	150	150	150

Table I. has been prepared on the basis of these limitations and gives a value for F in the equation

$$HP = \frac{V \times W}{F} \text{ or } W = \frac{HP \times F}{V}$$

in which HP is the horse-power, V the belt velocity in feet per minute, and W the width in inches.

TABLE II.

220°	210°	200°	190°	180°	170°	160°	150°	140°	130°	120°
980	1010	1040	1070	1100	1140	1180	1220	1270	1330	1400
810	830	860	890	920	950	990	1040	1100	1170	1240
730	750	770	800	830	860	890	930	980	1030	1100
500	570	590	610	630	650	670	700	730	760	800
460	470	480	500	520	540	570	600	630	660	700
420	430	440	450	470	490	510	530	560	590	630
390	400	410	420	440	460	480	500	520	540	560
320	330	340	350	370	390	410	430	450	470	490
290	300	310	320	330	340	360	380	400	420	440

Table II. gives corrected values for F when the arc of contact or wrap is greater or less than 180 deg. On large pulleys the creep may exceed 1 per cent. if the wrap is over 180 deg., as the increased friction gives a greater difference of tensions.

To illustrate the use of the tables, we will take the following examples:

How much horse-power will a 4 inch single belt transmit at a speed of 4,600 feet per minute passing over a 12 inch pulley? The factor is 920, therefore

$$\frac{4600 \times 4}{920} = 20 \text{ HP}$$

How wide should a belt be in order to transmit 50 horse-power at 2,000 feet per minute on 36 inch pulley?

$$W = \frac{50 \times 830}{2000} = 20.7\text{" single belt}$$

This gives us a width of single belt which is beyond the usual limit, 8 inches being considered good practice for the maximum width of a single belt.

$$W = \frac{50 \times 520}{2000} = 13\text{" double belt}$$

How wide should a single belt be in order to transmit 2 horse-power at 600 feet per minute over a 4 inch pulley with 140 deg. wrap?

In this case we take the factor 1,100 from Table I. and in Table II. find a corrected value for 1,100 under 140 deg. of 1,270.

$$W = \frac{2 \times 1270}{600} = 4.23\text{" single belt.}$$

How wide a belt is required for 300 horse-power at 2,000 feet per minute over 10 foot pulley?

$$W = \frac{300 \times 470}{2000} = 70.5\text{" double belt.}$$

This is too wide. Good practice calls for a change to triple at 48 inches unless for some special reason a narrower belt is necessary.

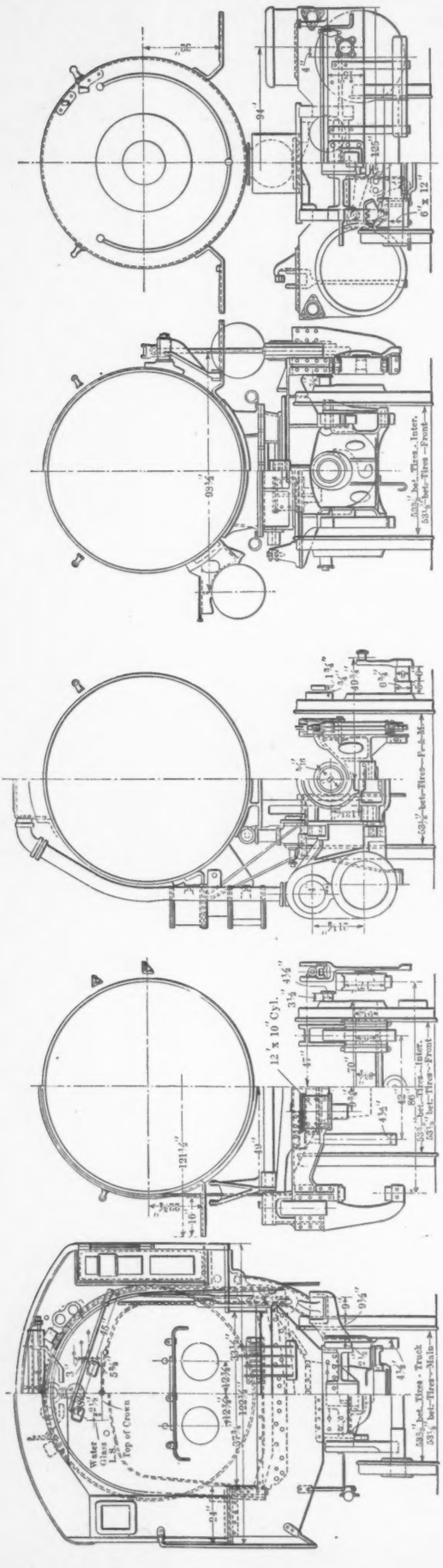
$$W = \frac{300 \times 330}{2000} = 49.5\text{" triple belt.}$$

The belt speed is limited by centrifugal force, but below 5,000 feet per minute the loss on this account is largely compensated for by the increase of friction due to the decrease in the time element of the contact, caused by the increased velocities.

The results given by these factors are well within working values and the belts will probably transmit 50 per cent. more power than these factors give, but at the expense of the life of the belt. A liberal allowance at the beginning means less annoyance, fewer delays in taking up the belts, longer life and less cost for renewals and repairs.

* Director of the Department of Mechanical Engineering, Worcester Polytechnic Institute.

† From the Journal of the Worcester Polytechnic Institute, Vol. XIII, No. 2, January, 1910.


Water Glass L.S. Top of Crown
12" x 10" Cyl.
Air Reservoir, R. & L. 22½" x 129"
15 Plates 5 x 5/16
410-2¼" Tubes
8½" Cross Comp. Air Pump, L.S. only
20½" x 32" Cylinder
33" x 32" Cylinder
Reversing Cyl.

GENERAL ELEVATIONS AND SECTIONS OF A MALLET ARTICULATED LOCOMOTIVE, 2-6-6-2, TYPE ON THE BOSTON AND ALBANY RAILROAD. THIS LOCOMOTIVE WEIGHS 342,000 LBS., OF WHICH 296,500 LBS., OR 87 PER CENT., IS ON DRIVERS. THE MAXIMUM TRACTIVE EFFORT (COMPOUND) IS 66,600 LBS. THE LOCOMOTIVE IS DESIGNED FOR USE IN THE BERKSHIRE HILLS SECTION OF THE ROAD.

MALLET ARTICULATED COMPOUND LOCOMOTIVE, 2-6-6-2 TYPE

A GENERAL DESCRIPTION OF A LOCOMOTIVE WITH LARGE BOILER CAPACITY BUILT FOR FREIGHT SERVICE ON THE BERKSHIRE HILLS SECTION OF THE BOSTON & ALBANY RAILROAD.

Between Springfield, Mass., and Albany, N. Y., the Boston & Albany R. R. passes through a country where heavy grades combined with sharp curves are practically continuous. There are several long sections where grades of approximately one per cent. are encountered and eastbound, the section of six miles between Pittsfield and Hinsdale is on a grade of 1.42 per cent. Westbound a grade of 1.5 per cent. 11.5 miles long is found between Chester and Washington, Mass. Very large consolidation locomotives, aided by pushers on the two heaviest grades, have been successfully used to handle the traffic over this division for a number of years. These locomotives have a maximum tractive effort of 45,700 lbs. and a total weight of 234,000 lbs. They are practically duplicates of the design illustrated and described on page 262 of the July, 1906, issue of this journal.

Experience on other roads with Mallet compounds indicates that a decided saving in operating charges can be made over a division of this character by their use and the officials of the New York Central Lines are considering the adoption of that class of locomotive for this service. The locomotive illustrated herewith was ordered from the American Locomotive Company for the purpose of determining its value in this particular case.

LARGE 2-6-6-2 TYPE LOCOMOTIVE BUILT FOR THE BOSTON AND ALBANY RAILROAD BY THE AMERICAN LOCOMOTIVE COMPANY. THIS IS THE FIRST EXAMPLE OF THE MALLET TYPE TO BE PUT INTO SERVICE ON THE NEW YORK CENTRAL LINES.

A comparison of the principal dimensions of the Mallet and the present standard consolidation locomotive are given in the following table:

Type.	2-8-0.	2-6-6-2.
Weight in working order	234,000 lbs.	342,000 lbs.
Weight on drivers	208,700 lbs.	296,500 lbs.
Weight on leading truck	25,300 lbs.	23,500 lbs.
Weight on trailing truck	.....	22,000 lbs.
Diameter of driving wheels	63 in.	57 in.
Cylinders, diameter and stroke	23 in. x 32 in.	20½ & 33 x 32 in.
Boiler Pressure	200 lbs.	210 lbs.
Maximum tractive effort, compound	.....	66,600 lbs.
Maximum tractive effort, simple	45,700 lbs.	80,800 lbs.
Driving Wheel Base (Rigid)	17 ft. 6 in.	10 ft. 0 in.
Engine Wheel Base	26 ft. 5 in.	46 ft. 4 in.
Heating Surface, tubes	3,474.8 sq. ft.	5,291 sq. ft.
Heating Surface, fire box	185.6 " "	185 " "
Heating Surface, water tubes	28.7 " "	
Heating Surface, total	3,689.1 " "	5,476 " "
Grate area	56.5 " "	56.5 " "
Average load per axle	52,175 lbs.	49,400 lbs.

From this it will be seen that the Mallet has about 45 per cent. more tractive effort than the consolidation engine, while the average weight per axle is about 2,775 pounds less, and the rigid wheel base 7 ft. 6 in. shorter. Another interesting fact evident from this comparison is that the grate area of the two classes is the same, which gives a much larger proportion of heating surface to grate area in the Mallet than has been the previous practice in locomotives of this type. Service tests of this type designed to burn bituminous coal have, however, proven that larger grate areas have hitherto been provided than were required for slow speed service. In this design, therefore, the grate area was reduced, thus facilitating firing and requiring a higher and possibly better rate of combustion.

With the exception of a larger boiler and larger truck wheels, this locomotive is practically duplicate in design to eight recently delivered by the same builders to the Denver & Rio Grande Railway. Exhaustive dynamometer and efficiency tests are now being made of this engine on the Pennsylvania Division of the New York Central.

In working order the engine has a total weight of 342,000 pounds, of which 296,500 pounds is carried on the driving wheels. The high pressure cylinders are 20½ in. in diameter by 32 in. in stroke, and the low pressure 33 in. in diameter by the same stroke. The boiler carries a working pressure of 210 pounds, and with driving wheels 57 in. in diameter, the theoretical maximum tractive power working compound is 66,600 pounds, which, with the Mellin system of compounding employed, can be increased to 80,800 pounds by working the engine simple.

One of the most prominent features of the design is the large boiler capacity that has been provided. This is apparent from a study of the principal ratios given below. In particular the figure of 693 for the B. D. factor is below the average for even simple engines designed for a similar class of service, and would indicate that the locomotive would deliver its full theoretical tractive effort at speeds higher than most of the previous Mallets in freight service have been designed for.

A very strong and substantial system of frame bracing has been employed. In the front system the frame bracing consists of a heavy cast steel crosstie at the back end, which is bolted to both the top and bottom rails of the frame, and to which the radius arm of the articulated connection is secured. A massive vertical steel casting located between the second and rear driving wheels, extends down to the bottom rails of the frames. The upper part of this casting extends outside of the frames and furnishes a support for the self-adjusting sliding boiler bearing. Another steel casting of similar design located between the first and second pair of driving wheels constitutes the guide yoke and also the support for a second boiler bearing. In addition there is a cast steel front deck casting ahead of the

cylinders which also serves for the engine truck center pin guide.

In the rear system, in addition to the cast steel foot plate at the back end, the cylinder casting and the steel casting at the front end, which includes the bearing for the center pin of the articulated connection, there is a heavy cast steel guide yoke across the upper rails of the frame between the first and second pair of driving wheels and the cast steel crosstie over the middle pedestal which furnishes the support for the front end of the firebox.

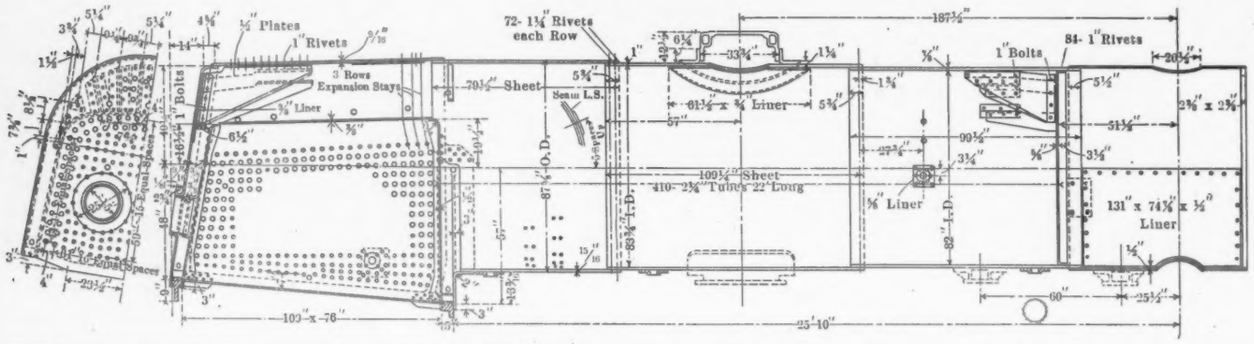
The front and rear systems are equalized together in the usual manner by vertical bolts connecting the upper rail of the front

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. Coal
Tractive effort	66,600 lbs.
Weight in working order	342,000 lbs.
Weight on drivers	296,506 lbs.
Weight of engine and tender in working order	494,700 lbs.
Wheel base, driving	10 ft.
Wheel base, total	30 ft. 8½ in.
Wheel base, engine and tender	74 ft. 8 in.

RATIOS.

Weight on drivers ÷ tractive effort	4.45
Total weight ÷ tractive effort	5.13
Tractive effort x diam. drivers ÷ heating surface	693.00
Total heating surface ÷ grate area	97.00
Firebox heating surface ÷ total heating surface, per cent	3.40
Weight on drivers ÷ total heating surface	54.00



VERY LARGE BOILER ON THE BOSTON AND ALBANY 2-6-6-2 TYPE LOCOMOTIVE. THIS BOILER HAS 22 FOOT TUBES, 5,476 SQ. FT. OF HEATING SURFACE, AND 56.5 SQ. FT. GRATE AREA. THE RATIO OF HEATING SURFACE TO GRATE AREA IS 97. THIS APPROACHES THE RATIO USED WITH NARROW FIREBOX BOILERS.

frame with the lower rail of the rear frame. As in the engines of this type built by this company for the Virginian Railway, the load on these bolts is supported by a coil spring through which the lower end of the bolt passes and which press up against the bottom of the rear frame rail, thus giving the flexible support at this point which is necessary in order that the three boiler supports, viz., the two sliding bearings and the equalizing bolt, may each bear its proportion of the load in any variation of the alignment of the three.

Both the front and rear trucks are of the center bearing

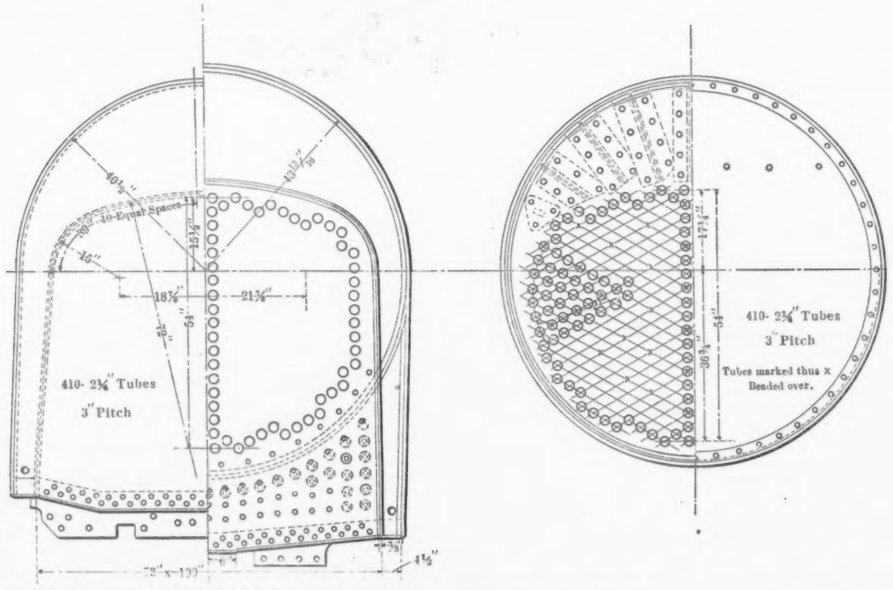
Total weight ÷ total heating surface	62.00
Volume equivalent simple cylinders, cu. ft.	19.32
Total heating surface ÷ vol. cylinders	283.00
Grate area ÷ vol. cylinders	2.92

CYLINDERS.

Kind	Compound
Diameter and stroke	20½ & 33 x 32 in.

VALVES.

Kind H. P.	Piston
Kind L. P.	Slide
Greatest travel H. P.	6 in.
Greatest travel L. P.	6⅛ in.
Outside lap H. P.	1⅛ in.
Outside lap L. P.	1 in.
Inside lap	¼ in.
Lead	3/16 in.



SECTIONAL ELEVATIONS OF BOILER. THE INSIDE FIREBOX SHEETS ARE VERTICAL AND THE TUBES ARE SET AT 3 INCH CENTERS. THEY SLOPE 1¾ INCH DOWNWARD TOWARD THE REAR.

radial type with swinging bolster and similar in design to that of the Virginian Mallet engines. The bolster is suspended by 3-point or stable equilibrium hangers. The truck frame is of cast steel and the portions of the sides over the journal boxes are shaped to form caps for the coil springs which transmit the load to the journal boxes upon which they are directly seated.

The principal dimensions and ratios of the design are given in the following table:

WHEELS.

Driving, diameter over tires	57 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	9 x 13 in.
Engine truck wheels, diameter	33 in.
Engine truck, journals	6 x 12 in.
Trailing truck wheels, diameter	33 in.
Trailing truck, journals	6 x 12 in.

BOILER.

Style	Straight
Working pressure	210 lbs.
Outside diameter of first ring	83¾ in.
Firebox, length and width	108⅛ x 75¼ in.
Firebox plates, thickness	⅜ and ½ in.

Firebox, water space	F-5, S and B 4½ in.
Tubes, number and outside diameter	410-2¼ in.
Tubes, length	22 ft.
Heating surface, tubes	5,291 sq. ft.
Heating surface, firebox	185 sq. ft.
Heating surface, total	5,476 sq. ft.
Grate area	565 sq. ft.
Smokestack, diameter	19⅛ in.
Smokestack, height above rail	14 ft. 10⅞ in.

TENDER.

Tank	Water Bottom
Frame	13 in. chan.
Wheels, diameter	33 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	8,000 gal.
Coal capacity	12 tons

COALING STATIONS.

To the Editor:—

Referring to the series of articles on Locomotive Terminals that appeared in your January, February and March numbers, particularly the section that considered coaling stations, I would like to make a few observations.

First, if the quantity of coal consumed by locomotives is to be accurately accounted for, the only possible solution is by weighing on scales. The question of measuring coal in a measuring pocket is a secondary question, and can only be used with any accuracy where the coal is of a uniform grade at all times, and even then, if an engine does not take an exact quantity of coal at all times, the means of obtaining accurate results are, to a certain degree, lost—*i. e.*, the man must guess at the amount.

I note in this section of the article that preference is given to the trestle type of chute where room permits, and it is stated that it has been the general custom to install this type of plant, and adds that the installation of it can be made at less expense. With the inclined type of stations, based both on a five per cent. grade, where the locomotive is used to push the cars up the incline, or a twenty per cent. incline, where the car hoist is used, we find that this station, in the first place, costs fully as much, if not more, than the mechanical types. Second, it can be designed to only coal economically one or two tracks. Third, the plants take up a great deal of room. Fourth, at the present time, or in fact since lumber has become scarce and we have been compelled to use Southern or yellow pine, the depreciation is greater than that of the housed plants, due to the fact that the inclines are long, especially the locomotive incline, and the question of maintenance is of decided importance. In the case of the five per cent. incline where a locomotive is used for pushing the cars up the incline, it is not customary to charge the time of the engine in service to the cost of handling the coal per ton, as the railway officials will usually say, "Well, we have a switch engine at that point, and this is part of its duties."

Regarding the Beacon Park plant, I wish to state that undoubtedly this trestle is the steepest of any in the country. The use of the goat at any of the incline types is very desirable, as it does away with draw-bar pull on the car direct, and also it is used to push the cars up the incline, and then can be lowered again into the pit below, and a second car is again pushed up the incline into the coaling station, and this performance can be repeated, depending upon the size of the chute and the holding capacity for the cars, viz., if the coaling station is long enough to hold three cars in length, three cars can be pushed up one after the other, and lowered away one at a time. This cannot be accomplished conveniently unless the goat is used. There have also been erected quite a number of plants of the steep incline type where scales are used successfully.

Regarding the locomotive crane for handling coal and operating the clamshell, the point at which it is to be used must be considered. This arrangement requires the services of a skilled mechanic at a higher price than is paid mechanics to operate the mechanical stations. Again, great care must be used so as not to damage the equipment, but in spite of close attention, the damage is bound to be considerable. Furthermore, the first cost of a crane is considerable, and we find by close observation that all kinds of coal cannot be successfully handled. In general, the coaling station matter is in its infancy yet, but great advancements have been made within the last six years.

The steel chain and small bucket type of plant is one that has great flexibility, and can be arranged to suit any condition. The large bucket type of stations using buckets of 1 to 2½ tons capacity give excellent service, and a great many of these are in operation.

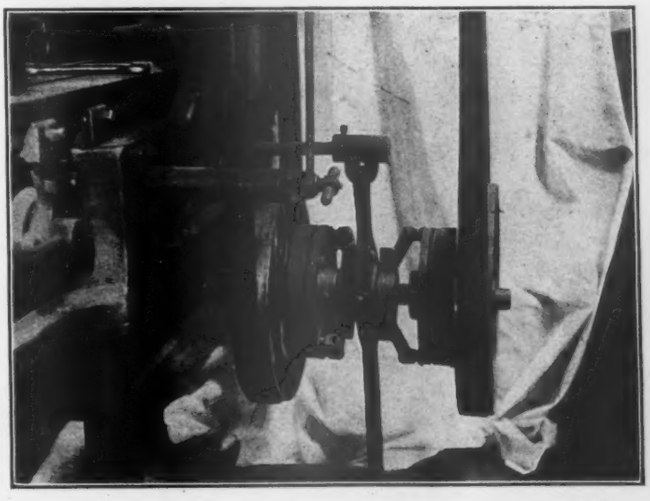
It is not my aim to describe the different types of coaling stations, but in conclusion I would like to sum up the subject as follows: In order to get successful results, the proper type of stations must be selected to meet all the conditions under which it is to operate, and it must be understood that each plant is a distinct and separate problem. Second, the use of self-cleaning cars is a most important factor. Third, emergency storage must be considered at certain points. Fourth, the equipment must be reliable, using the best kind of machinery throughout and with ample power. At highly important stations and where the amount of coal consumed per day is very high, it is feasible to install duplicate machinery. Fifth, the question of a fireproof structure must be taken into consideration. Sixth, where frame structures of any size are erected, fire protection should be provided, and it is essential to build the power house separate from the coaling station. Seventh, the question of switching cars is an important feature. A track arrangement should be so designed so as to reduce this to a minimum, and the plant should be provided with car-pullers of sufficient capacity. Eighth, the breakage of coal must be reduced to a minimum, and this has as yet not been considered to any great extent by the railroad companies. Ninth, good labor must be employed to operate the plants, and the machinery and equipment must be looked after thoroughly, and not only this, but a proper inspection must be made of the plants at intervals to insure them receiving proper care.

This last feature is most important and we find that a great many of the coaling stations throughout the country are run absolutely without any care whatever, and we have continuously recommended that, as the coaling station question is the most important and vital, every road should be provided with the necessary talent to look after the coaling stations and see that the plants are getting the proper care, and then, without a doubt, they will get better resuls.

CHICAGO. R. T. KRAUSCH.

A NEW CLUTCH PLANER DRIVE.

For reducing the wear on the belts, decreasing the power required and increasing the accuracy of the stroke of planers, a clutch drive has been designed by the American Twist Drill Company, Laconia, N. H. The general features of this clutch

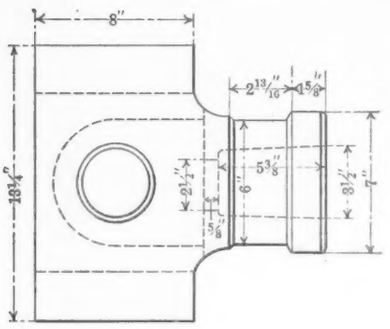


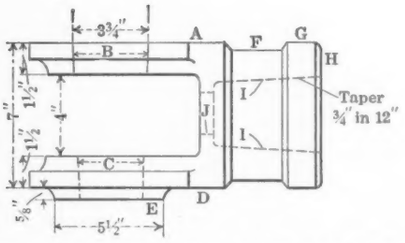
are clearly shown in the photograph, the shifting mechanism being operated by the table dogs in the usual manner. The clutch action is very positive and by its use the platen of the planer stops very close to the same point at each end of the stroke, being nearly as accurate as a shaper in this regard. It is designed for application to all standard planers.

OPERATIONS AND TIME REQUIRED FOR MACHINING CROSS HEAD ON A 36" VERTICAL TURRET LATHE.

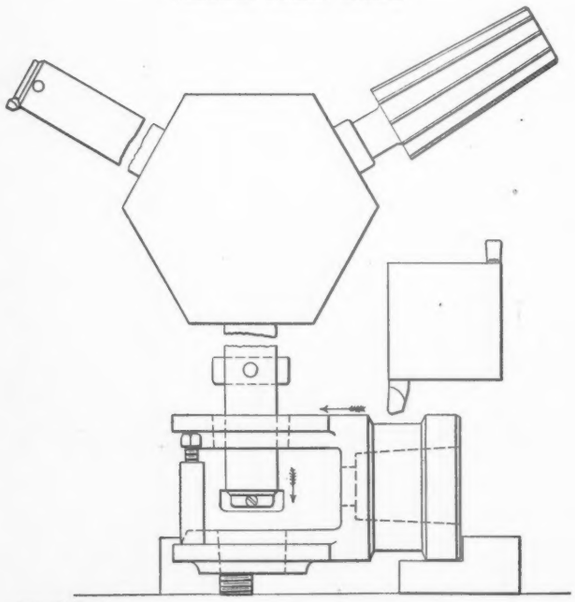
	Item.	Surface Machined.	Operations.	Depth Cut.	Feed per Rev.	Ft. per Min.	Min. each Oper.	Mins. req. Actual.
	1	.....	Chuck work	.....	.....	..	9	9
	2	A	Rough face A*	¼"	1/24"	45	15	15
	3	B & C	Rough bore B & C† *	⅜"	1/48"	..	15	
Setting No. 1	4	A	Finish face A	.....	1/12"	40	10	10
	5	B & C	Finish bore B & C *	.....	1/24"	..	10	
	6	.....	Ream	.....	Hand	25	5	5
	7	.....	Unchuck	.....	.....	..	3	3
	8	.....	Rechuck work	.....	.....	..	5	5
Setting No. 2	9	E & D	Rough faces E & D†	¼"	1/24"	45	13	13
	10	E & D	Finish faces E & D†	.....	1/12"	40	8	8
			Unchuck	.....	.....	..	3	3
	11	.....	Rechuck work	.....	.....	..	9	9
	12	I	Rough bore I	5/16"	1/48"	..	15	
	13	J	Rough bore J *	5/16"	1/48"	..	3	
	14	H G F	Rough turn H G F	¼"	1/48"	45	20	20
Setting No. 3	15	H G F	Finish turn H G F	.....	1/24"	45	18	18
	16	I	Finish bore I *	.....	1/24"	..	15	
	17	I	Extra cut I	.....	1/24"	40	9	9
	18	I	Ream	.....	Hand	..	5	5
	19	.....	Unchuck	.....	.....	..	4	4
			Total time, both heads				194	
			Total actual time elapsed					136

* Simultaneous cuts.
† Two tools working in same head.
Total saving time by use of Vertical Turret Lathe, 58 min., or 42%.



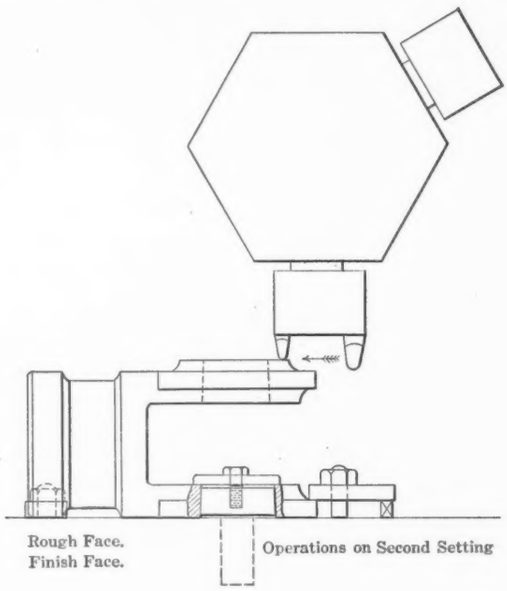


CROSS HEAD TO BE TURNED, BORED AND FACED ON VERTICAL TURRET LATHE.



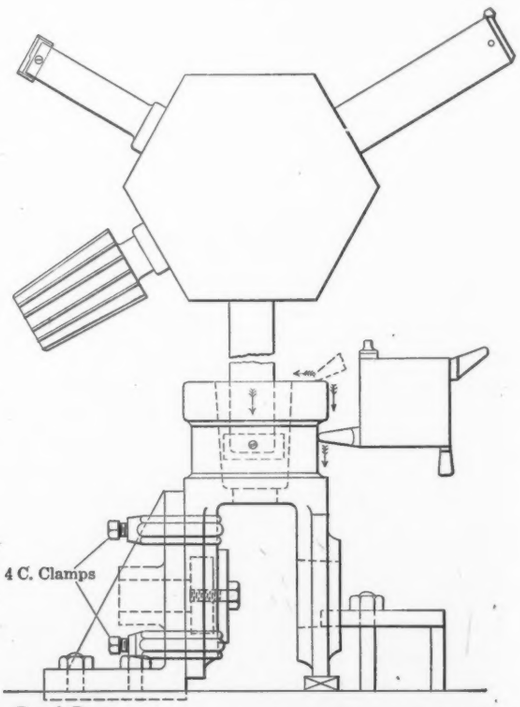
Rough Bore.
Truing Cut.
Ream.
Face. Rough & Finish.

Operations on First Setting.



Rough Face.
Finish Face.

Operations on Second Setting



Rough Bore.
Truing Cut.
Ream.
Face & Turn.

Operations on Third Setting.

MACHINING A LOCOMOTIVE CROSS HEAD ON A VERTICAL TURRET LATHE.

In the January issue, page 14, was illustrated the method of machining a locomotive piston on a vertical turret lathe, showing in detail how the work is completed in ninety minutes. The same machine is also capable of showing an equally good saving on many other classes of locomotive work, as, for example, cross heads.

The secret of the success of this machine in work of this character is, of course, the opportunity of setting all the tools required before starting operations and the ability to make simultaneously cuts, the speeds and feeds being capable of instant adjustment to suit the character of the cut.

In the present instance the cross head to be machined is shown in one of the illustrations and the work performed at each of the three seetings is also illustrated. In the table is given, in detail, the exact time required for each individual operation, the total elapsed time being 136 minutes or 2 hours and 16 minutes.

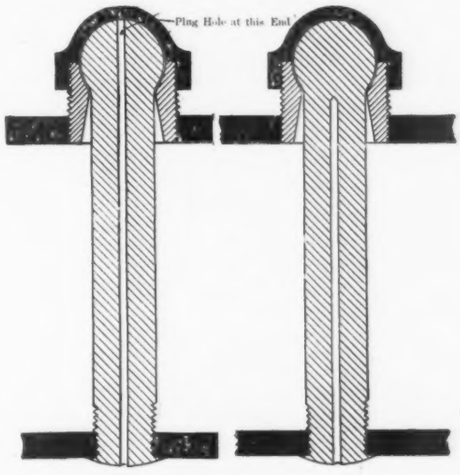
The machine for performing this work is a 36 inch vertical turret lathe manufactured by the Bullard Machine Tool Company, Bridgeport, Conn.

COMBINATION FLEXIBLE STAY WITH HOLLOW STEM.

To the Editor:—

The best method of testing flexible bolts, or how to tell when they are broken, has been a subject of considerable discussion at the last two or three Master Mechanics' and Master Boiler Makers' Conventions.

The interest of the inventors of flexible bolts to arrange a staybolt attachment at the outer sheet, which will, without straining the metal, respond freely to the expansion and contraction

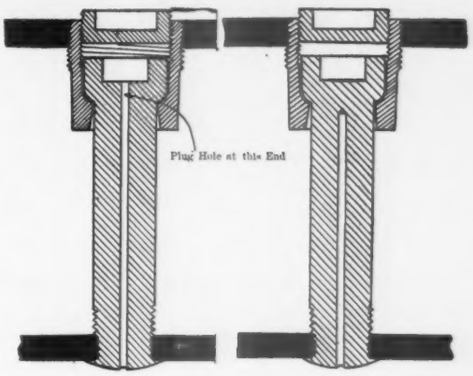


TATE FLEXIBLE STAYBOLT WITH HOLLOW STEM.

movement of the inner or fire sheet, is commendable, but we must not overlook the fact that any influence interfering with or retarding the free movement of the head will immediately convert it to the condition of a rigid stay. In other words, the vibratory strain will be thown on the metal as in the ordinary staybolt. Formation of scale or the precipitation of impurities in the water is liable at any time to interfere with the free action of the flexible head and thus bring about rigid conditions which it is desirable to avoid.

It is, therefore, quite as necessary that the flexible stay be covered by regulation staybolt inspection, the same as the solid bolt, and as a measure of satety this point should not be neglected. It is, however, impossible to detect broken flexible bolts by hammer sound, owing to the style of the flexible head attachment to the outer sheet. This leads to the necessity of removing the caps covering the heads in order to determine those actually broken. Removing and replacing those parts for the purpose of inspection means much labor and expense and is likely to cause delay to power.

To avoid this trouble I would suggest that the stems be made of hollow staybolt iron, as is shown in the illustration. Both service and laboratory tests have repeatedly demonstrated that



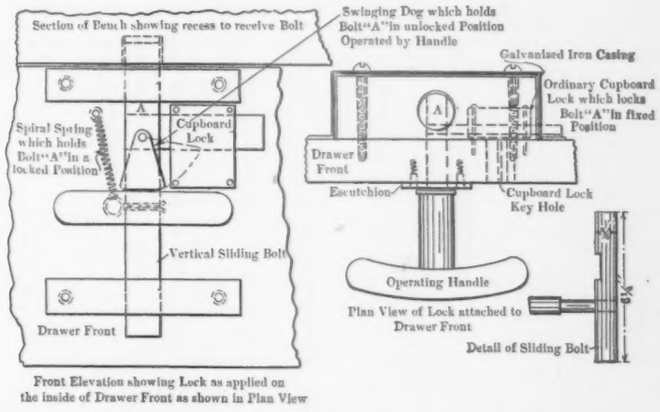
ACME FLEXIBLE STAYBOLT WITH HOLLOW STEM.

the hollow-rolled iron possesses over 50 per cent. greater endurance than solid iron, and if introduced in connection with the flexible head, it will add to the life of the stay and will in itself completely solve the question of inspection. With the use of the hollow stem a fully broken stay will not only be readily disclosed, but a fracture amounting to one-half its diameter will promptly make itself known.

John Hickey.

BENCH LOCK.

A combination handle and lock for bench drawers is shown in the illustration. The arrangement is such that a very substantial bolt secures the drawer in a closed position by the medium


Section of Bench showing recess to receive Bolt
Swinging Dog which holds Bolt "A" in unlocked Position Operated by Handle
Galvanised Iron Casing
Ordinary Cupboard Lock which locks Bolt "A" in fixed Position
Spiral Spring which holds Bolt "A" in a locked Position
Cupboard Lock
Drawer Front
Escutchion
Cupboard Lock Key Hole
Vertical Sliding Bolt
Operating Handle
Plan View of Lock attached to Drawer Front
Detail of Sliding Bolt
Drawer Front
Front Elevation showing Lock as applied on the inside of Drawer Front as shown in Plan View

of a very light and cheap lock. The arrangement and construction is clearly shown in the drawing and requires no description. These locks were applied by the contractors who built the Readville shops and have proven to be most satisfactory.

BALL PLAYERS, ATTENTION.

Leonard J. Hibbard, at the Crescent Athletic Club, Brooklyn, N. Y., chairman of the baseball committee of the Railway Supply Manufacturers' Association, will be glad to hear from any railroad or supply man who can, or thinks he can, play baseball. He has appointed Frank Martin of Jenkins Bros., New York, as captain of the eastern team, and Jack Ristine, of the Union Draft Gear Company, of Chicago, as captain of the western team.

Idle Cars.—On March 16 there was a shortage of 27,187 cars of all classes and a surplus of 44,529. This is about the same ratio that has existed for three months.